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BULLETIN

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METHODS FOR DETECTING SPOROZOITS AND ZYGOTES IN MOSQUITOS INFECTED WITH MALARIA.

By J. W. W. STEPHENS, M.D. Cantab., D.P.H.

Walter Myers Lecturer in Tropical Medicine, Liverpool School of Tropical Medicine.

Capture and Preliminary preparation of Mosquitos.

Where to find infected Anophelines.

(*a.*) Select a village or any small collection of native huts where you know, either from a blood examination or from spleen palpation, that the children are infected with malaria.

(*b.*) Anophelines and also Culicines will be found in the huts, near the fireplace, behind curtains, in cupboards, behind clothing, in old boots, collections of bottles, lumber, rubbish of all sorts, and on the thatch of the huts hanging to the sooty straw and cobwebs, often in hundreds. If none can be found, stir the thatch with a stick, as Anophelines frequently lie deeply hidden. Examine also out-houses, cowhouses, piles of dried grass in barns, and the outside of mosquito nets before the sun is well up.

(*c.*) In short drains or under bridges they may be sometimes caught in hundreds.

(*d.*) Or finally, "traps" may be set. These are made out of roomy biscuit tins (lined with felt), with the lid ajar. Mosquitos retreat into these as the sun rises.

Method of Capture.

Place a test tube or specimen tube *slowly* over the Anopheline, and then close it by slipping a plug of cotton wool into the mouth.

It will save a good deal of time if fifty mosquitos are required, to bring fifty test tubes instead of transferring each one when caught to a bottle. Also the trouble of getting them out of the bottle is avoided. But in case the supply of tubes is insufficient they should be transferred, as caught, into any *dry* bottle, such as a whisky bottle. There must be no obvious moisture in the bottle, as if there is, the mosquito is caught by its wings and soon dies.

Identification of Species.

There is still very little accurate knowledge as to which species actually do transmit malaria, and also as to which of these are the most concerned. It is essential then to identify, or to get identified, the Anopheline you dissect. A

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careful examination with a pocket-lens should enable you to state almost with certainty whether or no all the Anophelines you have caught are of the same species. Retain say a dozen, including some males, for examination by an expert. Kill them in the test tube by placing a drop of chloroform on the plug. Drop them on to a layer of very loosely fluffed cotton-wool in a pill-box or match-box. Place a very thin layer of loosely fluffed cotton-wool over them to prevent shaking. If obtainable, add one drop of creosote to the inside of the lid of each box to prevent mould, or melt a little naphthaline and pour it into the lid.

Put a label outside the box stating *when* and *where* caught and *name of sender*. Dispatch home at once.

Dissection of a Mosquito.

Killing.—This is most easily done by concussion, *i.e.* rapping the tube, with the mosquito at the end, smartly against the knee. (N.B.—This must on no account be done if the mosquitos are required for identification, as most of the scales are knocked off in the process).

Trimming.—Put the mosquito on a slide, and while holding one wing pull off with a needle or forceps the legs and remaining wing. Take care not to pull off the proboscis by mistake.

Dissection of Salivary Glands.

(*a.*) Put the trimmed mosquito into a drop of salt solution (1 per cent. roughly) on a slide so that it lies on its *right* side with its proboscis *towards* you (fig. 1).

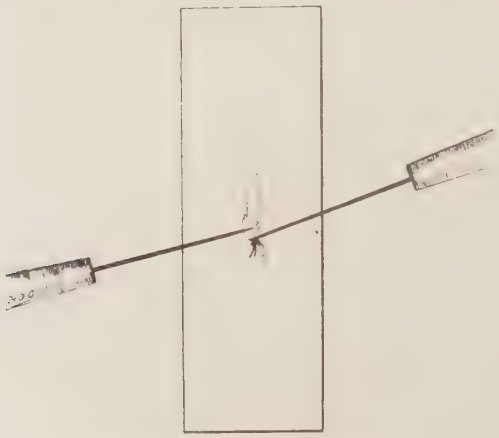

Fig. 1.—Diagram to illustrate the method of extracting the salivary glands of a mosquito.*

* This drawing has been kindly made for me by Mr. H. F. Carter, Assistant Entomologist, Liverpool School of Tropical Medicine.

Do not *flood* the slide with salt solution as the glands when extracted may float away and be lost. Remember that the glands lie just at the point of origin of the first pair of legs.

(*b.*) Place the slide upon a piece of *white paper*, as you are dissecting a dark object. Take a needle (in a holder if convenient) in each hand, holding them nearly horizontal. Place the *left* needle *on the thorax* so as to steady it and the *right needle at the back of* the head (fig. 1), and now make a series of gentle, slow, "coaxing" pulls on the head with the right needle, taking about $\frac{1}{4}$ $\frac{1}{2}$ a minute over it.

(*c.*) If this has been done carefully (and anyone with the least delicacy of touch can succeed 99 times out of 100), a bit of white tissue is now seen attached to the head. This contains the glands.

(*d.*) Examine under about $\frac{1}{2}$-inch lens, remembering nearly to close the diaphragm as an unstained object is being examined. The glands are glistening, finger-like and a little twisted, and project from the end of the head, or possibly only their tips may be seen in the midst of some grey muscle or "fat body."

(*e.*) Separation from head:—Put the *left* needle on the head and with the *right* cut or tear off the white tissue containing the glands. (N.B.—*Take care that by this time the salt solution has not dried or that the glands have not stuck to the needle.*)

Examination of the Glands.

(*a.*) The glands are generally quite free when dissected in this way, but even if still attached to a bit of tissue it is quite unnecessary to separate them any further. It is not necessary that all six lobes should be present, three may be considered sufficient (fig. 2). Note the exact position on the slide with a low power.

Fig. 2.—The salivary glands of one side.

(*b.*) If the salt solution has become turbid carefully draw the glands into a fresh drop of solution on the slide, remembering that *apparent* right and left under the microscope are *actual* left and right on the slide.

(*c.*) Drop a cover-glass over them.

(*d.*) Examine with a $\frac{1}{6}$ or $\frac{1}{7}$ inch lens. An oil immersion is unnecessary for *detection* of sporozoits as they are in length about twice the diameter of a red cell.

(*e.*) Sporozoits are seen in such a fresh preparation in hundreds as thin, rather glistening, curved rods. The diaphragm should be properly adjusted (fig. 3).

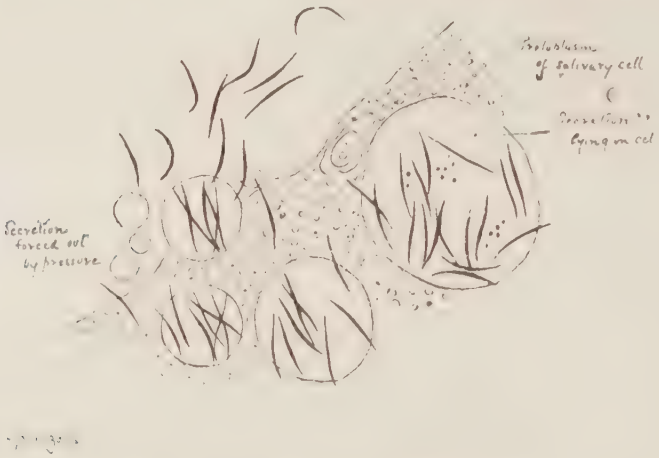

Fig. 3.—Sporozoits in the salivary gland.

Staining of Sporozoits.

(*a.*) Smear off the cover-glass.

(*b.*) Dry as rapidly as possible (over flame).

(*c.*) Fix in alcohol for a few minutes—5 is ample.

(*d.*) Stain in Romanowsky or Leishman, &c.—10 minutes or longer.

Compare carefully sporozoits from quartan, simple tertian and malignant tertian cases. Also examine if there is any evidence of ♂, ♀ and indifferent sporozoits.

Dissection of the mid-gut (stomach).

N.B—Keep the mosquitos, if caught in huts, for two to three days till the blood is all digested, as it is otherwise almost impossible to see zygotes.

(*a.*) Place the mosquito (either a fresh one or the one from which the glands have been extracted) *on its back* in a drop of clean salt solution. With a needle, nick or tear the chitinous body wall on each side as near the "tail" as possible. Place the *left* needle on the thorax and with the *right* needle on the extreme tip make a gentle traction as before.

(*b.*) If carefully done, all the viscera will be pulled out, viz., oesophagus and diverticula, mid-gut, Malpighian tubes (5), hind-gut, ovaries (2), &c. When the tension is relieved the mid-gut assumes a flask-shaped saccular appearance.

(*c.*) Cut the mid-gut off just below the Malpighian tubes. Also cut through the upper end of the oesophagus to which may be still attached the diverticula—recognisable by the gas bubbles (CO_2) they contain.

(*d.*) Remove everything from the slide except the mid-gut (stomach). Add a clean drop of salt solution. Drop on a cover-glass and press gently, so as to flatten out the stomach. Examine with a $\frac{1}{6}$-inch lens, taking care to adjust the diaphragm properly.

(*e.*) If the normal structures of the stomach are known there is no difficulty in recognising zygotes.* (Fig. 4.)

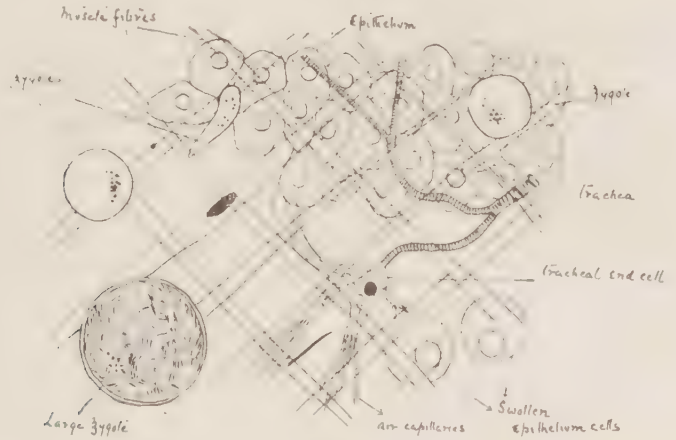

Fig. 4.—Microscopic appearance of mid-gut, showing cell-structure and zygotes.

(1.) The younger forms are clear oval or round bodies 6–7μ, *i.e.*, about the size of a red corpuscle, containing *definitely seen pigment granules.*

(2.) The larger forms have a *distinct cyst wall* (oocysts) and still retain pigment which is unmistakable.

(3) The largest oocysts have lost their pigment and are clearly defined cysts (40–60μ) filled with hundreds of sickle-shaped bodies (sporozoits) which escape on rupture.

(*f.*) "Black spores" (Ross).—Although very many dissections of Anophelines were made by Christophers and myself in Africa, these brownish or black sausage-like bodies which sometimes are found in the large oocysts were never seen by us. In India we saw them only twice, in hundreds of dissections, and on both these occasions they were in the region of the salivary gland. They are, however, far commoner in the oocysts of Culicines fed on *Proteosoma*. According to some authors they are parasitic sporozoa, but nothing is known as to their life-history.

Staining of Zygotes.

(*a.*) Draw some 10 per cent. formalin solution under the cover-glass by means of blotting paper, and float off the cover-glass carefully. The stomach will probably remain attached to it.

(*b.*) Wash in water.

(*c.*) Stain lightly with methylene blue.

(*d.*) Wash in water, dehydrate, clear in xylol.

(*e.*) Mount in balsam.

Good preparations are easily obtained in this way.

* Zygotes if scanty (1 or 2) will be found at the bottom end of the stomach nearest the Malpighian tubes.

Parasites that may be met with during Dissection.

1. Trematodes—encysted in the thorax, also free in the stomach.

2. Nematodes—in the thorax or abdominal cavity. In the thoracic muscles, filarial larvæ may also be found.

3. Sporozoa—(*a*) masses of sausage-shaped bodies about the salivary glands; (*b*) sporocysts containing 8 spores—these occur in large numbers replacing the yelk of the eggs (Fig. 5); (*c*) gregarines, free in the stomach or encysted in the Malpighian tubes.

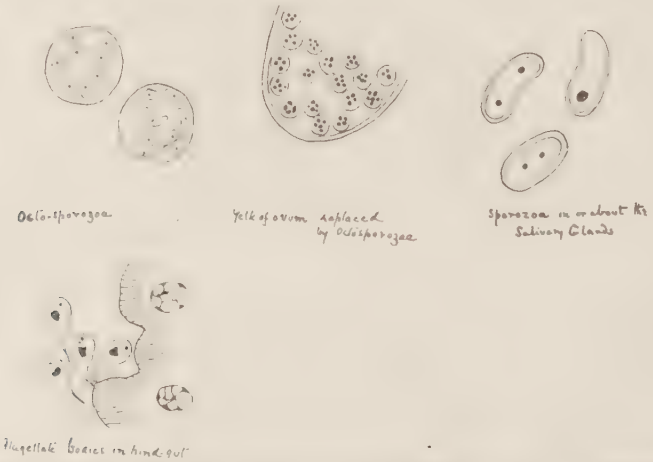
Oöcio-sporozoa.
Yelk of ovum replaced by Oösporozoa
Sporozoa in or about the Salivary Glands
Flagellate bodies in hind gut

Fig. 5.—Protozoa other than the malarial parasite found in Anophelines.

4. Flagellata—in large numbers in the gut. They are *Crithidia*-forms.

5. Micro-organisms and *Nosema* (?) in the diverticula.

6. Ecto-parasites—The reddish larval stages of water-mites (Hydrachnidae) are common. The adult stages of these are unknown.

Infection of Anophelines.

Our information on this subject is deplorably inadequate. A systematic examination of suspected species at all seasons of the year would certainly yield results of considerable practical value. The following are examples of some of the results already obtained (Stephens and Christophers):—

Locality.	Species of Anopheline.	Percentage infected with sporozoits.
Lagos Town	*Pyretophorus costalis* ...	3
Olokemeji (S. Nigeria)	*Myzomyia funesta* ...	50
Aro (S. Nigeria) ...	*Myzomyia funesta* ...	25
Mian Mir (Punjab) ...	*Myzomyia culicifacies*...	4·6
	Myzomyia rossii ...	0
Ennur (Madras) ...	*Myzomyia culicifacies*...	8·6
	Myzomyia rossii ...	0

Nor should the Culicines be neglected in this respect. An investigation of the commoner house-frequenting species might yield important information.

Problems concerning the Infection of Mosquitos which need further Investigation.

1. Bodies of uncertain significance found in the Salivary Glands of various Mosquitos.

(*a.*) In a large Anopheline (*Myzorhynchus ? sp.*), a species not frequenting houses, caught in the bush in Sierra Leone at a considerable distance from human habitations, sporozoits were found in one out of four examined. The nature of these is unknown, and further observations are much needed.

(*b.*) The examination of specimens of an undetermined species of *Culex* at Mabang, Sierra Leone, showed that 10 per cent. contained bodies resembling sporozoits, but more slender, twisted and irregular in outline. Some of these Culicines had fed on human blood, others were caught in the bush. Here again we have no knowledge as to the nature of these bodies.

(*c.*) In another undetermined *Culex*, 5 to 10 per cent. of the specimens contained straight bodies in the globules of salivary secretion. These resembled sporozoits, but were probably crystalline in nature.

2. Alleged transmission of Malarial Infection through the Eggs of the Mosquito.—Statements have been made, without a vestige of proof, that such transmission occurs. It may be well, therefore, to examine the eggs of Anophelines for sporozoits. Even should infected eggs be found, it would not be clear how they could transmit infection to the adult mosquito hatched from them, as there is no evidence that the sporozoits multiply or undergo further development in the mosquito. If we suppose that hereditary transmission does occur, the form of the parasite may be quite different from anything we know. Hence the study of the contents of normal eggs is of importance.

3. What are the conditions which determine successful infection of Anophelines fed on malarial blood?—In feeding experiments only a certain percentage are as a rule successful. In experiments made by Christophers and myself in India we got no result until we kept the Anophelines in a hot incubator, though in the villages they were naturally infected. Is it quite certain that no Culicines can transmit malaria?

4. How many persons can one Anopheline infect?—We have no data on this point. In the case of Culicines the brothers Sergent have shewn that an infected Culicine can infect two, but not three consecutive birds with *Proteosoma*. Similar experiments might be made in the case of Anophelines and man, but in case this is not possible the experiments should be made with Culicine sporozoits on birds; and, indeed, if opportunity offers, bird-malaria still affords a fruitful field of research. In the greater part of Africa, however, *Proteosoma* does not exist, but in the mode of transmission of *Halteridium*, Haemogregarines, &c., there is abundance of work to be done.

4. Does the percentage of infected Anophelines vary from month to month, and if so, to what extent?

5. How long does an Anopheline once infected remain so?

6. Penetration of red cells by sporozoits.—Using a mixture of finger-blood and sporozoits from the salivary gland, Stephens and Christophers were unable to observe penetration of the red cell by the sporozoits, but the latter appeared to change into rings. Nor did Schaudinn, making the same experiment, succeed, but on using sporozoits taken from a large oocyst in the stomach he was successful. These experiments are worthy of repetition and an explanation should be sought for the difference in the behaviour of the sporozoits from the two sources, if the facts are correct.

7. Properties of the salivary secretion.—As far as I am aware, nobody has yet repeated Schaudinn's observations. He states that the salivary gland rubbed into an abrasion does not produce the irritation of a mosquito bite, but that on the contrary if the oesophageal diverticula be rubbed in, the well-known itching effects are experienced, which he attributes to the enzymes produced by low bacterial forms in the diverticula. Any fact established about mosquitos is of value for we never know to what practical purpose such knowledge may not be turned.

Suggested lines of Research in the Life-history of Adult Mosquitos.

Finally, in addition to the problems we have indicated as awaiting research dependent mainly on microscopical methods, there are numerous points concerning adult mosquitos (apart from larvæ) on which further light is required, problems which are to be solved rather in the field than in the laboratory. Such for example are :

1. Length of life.
2. Distance of flight. It might be possible to mark mosquitos, *e.g.*, with a stain or powder, and to trap them again.
3. Habits, especially of the male, and conditions of fertilisation.
4. Effect of jungle, bush, bamboo-thickets, and banana-clumps as screens. Is it advisable to clear all jungle indiscriminately, without regard to its screening function ?
5. What are the natural enemies of adult Anophelines ?
6. Is it possible to discover any plant or substance that will entirely repel mosquitos ? or on the contrary that will irresistibly attract them ?
7. What is the best form of mosquito trap and to what extent can mosquitos be diminished by persistent trapping every night in native huts or European bungalows ?
8. Habits in the dry season.
9. When does egg-laying of Anophelines take place in nature ? Has it any relationship to food ? What determines selection of any particular water ?
10. How often does an Anopheline leave a native hut or bungalow ?

A REVISION OF THE TSETSE-FLIES (GLOSSINA), BASED ON A STUDY OF THE MALE GENITAL ARMATURE.

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The examination of the armature of the males of all the hitherto described species of the genus *Glossina*, with the exception of *G. maculata*, Newstead,* has not only revealed some very striking morphological characters, but has led to the discovery of three new species† and the re-establishment of Bigot's *G. grossa*.‡ One of these new species, *G. submorsitans*, Newstead, has hitherto been overlooked through its striking similarity to *G. morsitans*. Morphologically these two species are separable chiefly by the small but important organs herein described as the median lobes; these characters will be best understood by reference to the accompanying figures (figs. 15*ml*, 16*ml*), in which the difference is as well marked as that between the holoptic and dichoptic heads found in certain groups of Diptera. *G. palpalis*, R. D., and *G. tachinoides*, Westw., are also very closely allied in the general form of the armature of the males, but they are easily separable by the minute differential characters of the inferior claspers (figs. 9*ic*, 11*ic*).

The scheme of classification here adopted for the members of this small, but very highly specialised genus, is, I believe, contrary to nearly every precedent, in so far as it begins with the lower and rises to the higher or more complex forms. It is based entirely upon the taxonomic characters of the armature of the males, which afford a natural and reliable guide for discriminating the superficially similar species, and indicate very clearly the alliances and distinctions which exist among these insects. That the species fall into three very striking and distinct groups may be easily gathered from a study of the illustrations accompanying this memoir, each group being distinguished by very trenchant characters. These are :—

Group I.—The Fusca Group.

This division includes the four largest species of the genus : *G. fusca*, Walk., *G. nigrofusca*, Newst., and *G. tabaniformis*, Westw., which have a western distribution : *G. longipennis*, Corti, and *G. brevipalpis*, Newst., occurring chiefly on the eastern side of the continent. In all of these species the superior claspers are quite free, there being no membrane stretching between them ; the distal extremities of these appendages have either a single large and bluntly-pointed tooth-like extension, or they are bluntly bidentate : the harpes in all cases being markedly different in structure.

* The only example known is unfortunately a female.

† Ann. Trop. Med. and Parasit., vol. iv., pp. 369–375 (1910).

‡ [After a careful re-examination of the types, Mr. E. E. Austen agrees with Mr. Newstead in regarding *G. grossa*, Big., as distinct from *G. fusca*, Walk., but he considers it conspecific with the earlier *G. tabaniformis*, Westw., which name will stand. Mr. Austen is further of opinion that the species provisionally referred to *G. grossa* by Mr. Newstead is not the same as Bigot's insect, and must therefore be known as *G. nigrofusca*, Newst., the name tentatively suggested for it by Mr. Newstead (*l.c.* p. 370).—Ed.]

Group II.—The Palpalis Group.

To this division belong the following species:—*G. palpalis*, R.D., *G. caliginea*, Aust., *G. tachinoides*, Westw., *G. fuscipes*, Newst., and *G. pallicera*, Big. In all of these the superior claspers of the males are connected by a thin and finely spinose membrane which is deeply divided medially, but in all cases the distal extremities of the claspers are quite free and widely separated. In *G. palpalis* and *G. tachinoides* the claspers are identical in structure, though generally those of the latter are relatively smaller: in both species, also, the distal portion is produced into a single more or less falciform or tooth-like process. The claspers in *G. pallicera* are suddenly truncated* at the distal extremity, the inner half of which is furnished with minute spines: furthermore, they are much broader basally than in the other species which are included in this group.

Group III.—The Morsitans Group.

This group comprises *G. morsitans*, Westw., *G. submorsitans*, Newst., *G. pallidipes*, Aust., and *G. longipalpis*, Wied. In these the superior claspers are completely united by a spinose membrane and they are also fused medially. That they are of a very remarkable form may be gathered by a glance at the illustrations (figs. 14, 15, 16 and 17), their shape somewhat resembling the scapula of a mammal in miniature, and they are altogether much more highly complicated structures than those in either of the preceeding groups.

Thus we see, in these three groups, forms which are so widely different as to lead one to assume, without taking the other external features into consideration, that they represent three distinct genera. Certain it is that these insects afford an interesting illustration of the fact that a high degree of differentiation in one set of morphological characters is not incompatible with the retention of others apparently of a more ancestral type.

General characters of the Male Armature.†

The sexual organs of the males of all the species of the genus *Glossina*, as has been shown, are strikingly characteristic in form. Externally the hypopygium (fig. 1) is broadly oval in shape and is highly convex, "its longer axis lying in the antero-posterior direction, with a vulviform median groove (the anus) running from the anterior margin to beyond the middle."‡ This hypopygium is articulated to the eighth abdominal segment; and when closed (fig. 1) the armature is completely hidden: the superior claspers (fig. 1*sc*) then lie in a horizontal position with the apices pointing towards the distal portion of the abdomen. If

* The distal margin may eventually be found to possess a tooth-like process similar to that in other members of this group, but there is no trace of these in the example before me: further details cannot be given until more material comes to hand.

† Weseché (Trans. Linn. Soc. Lond. 2nd ser. Zool. IX., 1906, pp. 339-386, pl. 23-30) has dealt with the armature of four species of *Glossina*, but unfortunately I find myself unable to agree with many of his statements and conclusions. There is also an earlier paper by the same author (Journ. Quek. Micr. Club, 1905, p. 236) dealing exclusively with the genitalia of *Glossina palpalis*.

‡ Austen. Monograph of the Tsetse flies, p. 65.

macerated in caustic potash for a few minutes this organ, which is really a modified segment of the abdomen, can be turned backwards, as shown in fig. 2, so

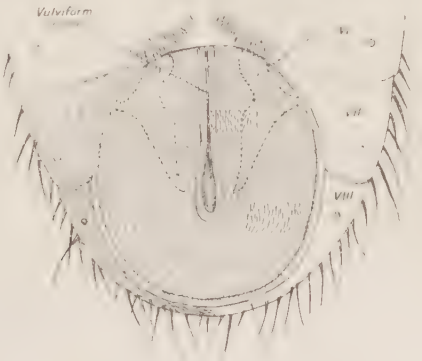


Fig. 1.—Hypopygium of male *Glossina*, as seen when closed ; the dotted lines indicate the position of the superior claspers beneath it.

that its ventral surface together with its various and complicated structures are displayed. These appendages are :

1. *Superior Claspers* (*sc* in all the figures). The position of these organs when the hypopygium is closed has already been described and it is indicated by the dotted lines in fig. 1*sc*. These organs can be erected to an angle of varying degrees ; but in life they are never extended backwards so as to lie in a horizontal position or in the same plane as that of the abdomen, and considerable pressure is necessary to bring them into this position (see dotted lines in fig. 2).

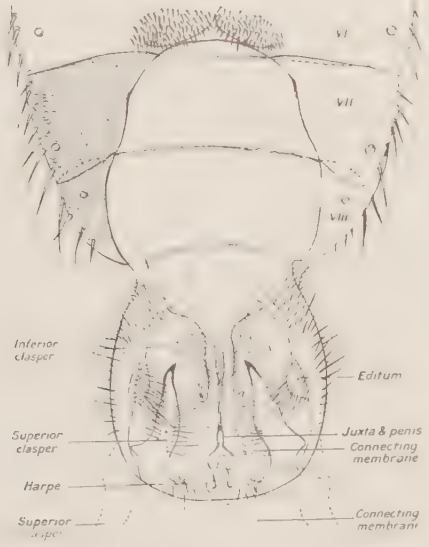


Fig. 2.—Hypopygium of male *Glossina* extended backwards so as to display the genital armature.

Their chief function is apparently to grip the abdomen of the female, and in several examples of *G. morsitans* and *G. submorsitans*, the distal margins present a distinctly chipped or worn appearance : whether this is produced by the act of coition or otherwise is uncertain. These organs are furnished with numerous slender bristles some of which are of great length, more especially so in *G. longipalpis*.

2. *Editum* (*e* in all the figures). This is a flange-like extension of the body-wall and is invariably furnished with a number of bristles, some of which are of great length and may extend to the middle area of the superior claspers (*see* fig. 14, p. 29).

3. *Inferior claspers* (*ic* in all the figures). These are very important organs, as they afford, in many instances, very striking morphological differences, by which closely allied species may be determined. They are very large in the *fusca* group : and in the *palpalis* group they are deeply folded at their bases, and the distal extremities are curiously modified. In the *morsitans* group they are not very clearly defined and their true structure has not yet been adequately determined, owing to the complicated folds which they present : for this reason also they are not shown in the illustrations. The function of these organs is at present unknown : but it should be a comparatively easy matter to find out in specimens preserved in coitu.

4. *Harpes* (*h* in all the figures). These organs are bilateral, and are most highly developed in the *fusca* group, more especially so in *G. fusca*. In the remaining groups these appendages are more or less rudimentary and very similar in form.

5. *Juxta* or *penis sheath* (*j* in all the figures). In all of the species included in groups II and III this is more or less tubular in form, with the distal portion strongly dilated and more or less deeply divided.

6. The *penis* (*p*) which lies in the middle of the sheath is a slender tube-like organ dilated distally, the extremity, in some instances (*G. longipalpis*, etc.) bearing four or five minute perforations. The *vesica* (*v* in all the figures) is a thin membranous extension of the juxta, supported, apparently, by the harpes. In *G. fusca*, *G. nigrofusca* and *G. brevipalpis*, it forms a complete tube presenting many irregular longitudinal folds and in some cases (*G. nigrofusca*) regular transverse ones also. In the species included in groups II and III it is quite rudimentary and in some species it resembles the harpes both in form and size, so far at least as one can judge by viewing it in optical section.

7. *Median process* (*mp* in all the figures). This organ has been found only in the *fusca* group. It lies in the position in which one would expect to find the anus : but it appears to be a non-tubular process and it is so highly chitinised in *G. brevipalpis* as to resist the action of stains. It lies in the middle line between the inferior claspers, and is slightly dilated distally and deeply grooved medially along its upper edge.

8. *Connecting membrane* (*cm* in all the figures). This is present in the *palpalis* and *morsitans* groups, but is absent in the *fusca* group. It is in all cases finely spinose and, when at rest (fig. 2), lies folded on either side of the median line.

Methods of preparing the male genitalia for microscopical examination.

The specimens used in the preparation of this memoir were all in a perfectly dry condition so that it was necessary to macerate them in order to be able to turn the hypopygium back and display the various structures. The best method is as follows :—

1. Either break off the abdomen close up to the thorax or clip it off with a pair of scissors midway in the region of the third or fourth segment. It is best, however, to leave as much of the abdomen attached as possible so as to facilitate the final mounting of the preparation. The armature can also be dissected out with a fine scalpel, but the result is not nearly so satisfactory; though this method may be adopted in the case of rare and valuable specimens.

2. Place the abdomen in a test tube and partly fill it with 10 per cent. caustic potash (K O H). Write with a *pencil* on a slip of paper the full data and place it in the upper portion of the tube, away from the liquid. Place the tube in a water-bath and boil over a bunsen for fifteen minutes.

3. Remove from the potash and wash in clean water for five minutes. Then take a No. 1 sable brush and roll it *towards* the hypopygium until the latter is as fully distended as possible; repeat the process until all the dirty fluids (dissolved body-fats, etc.) have been expelled.

4. Immerse for five minutes in 50 per cent. alcohol; and for an equal time also in absolute alcohol, taking care that the claspers are kept well distended.

5. Immerse in clove oil for ten minutes, again displaying the claspers with the brush. If the preparation has not cleared thoroughly it is a good plan to heat the oil, which will remedy the defect immediately.

6. Place the abdomen on a glass slide and with the larger species put two small broken fragments of a cover-glass, one over the other on either side of it in order to relieve the pressure of the cover-glass. With the smaller species (*morsitans*, etc.) this method is not needed.

Staining with Carbol Fuchsin brings out certain details very clearly; but unless the student has had previous experience in this method it is not advisable to adopt it.

All the members of the *fusca* group must be mounted so that the armature may be studied in profile; though a dorso-ventral position is necessary for the determination of the width between the superior claspers. Members of the groups II and III must be mounted in a dorso-ventral position, otherwise the superior and also the inferior claspers will not show properly: care must also be taken to place all of these with the *venter uppermost*. The Canada balsam should not be too thin and both the slide and cover-glass should be warmed over a bunsen or spirit lamp.

The species belonging to groups I and III can be mounted with comparative ease; but those belonging to group II are somewhat difficult owing to the tendency of the superior claspers to fold back over the hypopygium, but with care they can be fully distended, and this is absolutely necessary, otherwise the surrounding organs will not be properly displayed. In all cases where it is necessary to mount the examples in profile the abdomen must be placed upon its

side and the armature extended by the pressure of the brush in the same way as when a dorso-ventral mount is required, as if the abdomen is flattened dorso-ventrally in the first instance, it is a most difficult matter to flatten it in the opposite direction subsequently.

Caution.—Do not use a brush of any kind to manipulate the preparation while it is in the potash—the hairs will shrivel in this re-agent.

Synopsis of the Species of Glossina.

Group I (Fusca Group). Large species, length exclusive of proboscis 10¾–12 mm.

A. Thorax with the usual longitudinal markings more or less distinct.

Palpi relatively long and thin. Thorax russet brown, markings distinct, areas enclosed by the curved lines becoming gradually paler outwardly. Third segment of antennae clothed with very short pubescence. Harpes of male with a strongly serrated margin; median process not extending beyond the inferior claspers.
1. *fusca*, Walk., p. 15.

Palpi as in 1. Thorax smoky brown, pale markings sharply and clearly defined. Third or terminal segment of antennae clothed with very long pubescence, and with apex strongly recurved. Harpes of male not serrated; median process projecting moderately beyond the inferior claspers. 2. *nigrofusca*, Newst., p. 17.

Palpi relatively short and stout. Thoracic markings not very clearly defined. Third segment of antennae with very short pubescence. Median process in the armature of the male more than twice the length of the inferior claspers; harpes not serrated.
3. *brevipalpis*, Newst., p. 19.

B. Thoracic markings reduced to spots.

Thorax with four (sometimes six) dark brown oval spots, the four larger ones arranged in a parallelogram. Harpes of male clothed with large squamose spines. 4. *longipennis*, Corti, p. 21.

Group II (Palpalis Group). Hind tarsi all dark. Length 7–9½ mm.

Thorax, legs and abdomen spotted. 5. *maculata*, Newst., p. 22.

Abdomen very dark brown or blackish brown, with a small median pale triangular area on second segment, extending distally as a very narrow stripe. Inferior claspers of male with a long broad stem to the foot-like terminal process; superior claspers straight, rapidly narrowing distally and terminating in a conical point. 6. *palpalis*, R. D., p. 22.

Similar to *G. palpalis*, "but browner and somewhat larger . . . pale area on second segment broad and more or less quadrate or irregular in outline . . . dorsum of seventh abdominal segment . . . often cream-buff."* Superior claspers of male with a terminal tooth-like extension one-third the length of the clasper. 7. *caliginea*, Aust. p. 23.

* Austen, Bull. Ent. Res., I., p. 294 (1910).

Small and slenderly built. Abdomen pale, with distinct transverse blackish bands; median pale stripe very distinct. Legs with the exception of the hind tarsi and the tips of the front and middle ones, pale yellowish. Inferior claspers of male with a very short stem to the foot-like terminal process; superior claspers as in 6. 8. *tachinoides*, Westw., p. 25.

Small and stoutly built. Abdomen as in 6, but with the usual transverse dark bands more evident. Thorax dusky grey with four greyish-black, triangular, blotches. Legs almost uniformly infuscated. Superior claspers of male curved and terminating in a claw-like point.

9. *fuscipes*, Newst., p. 26.

Abdomen almost unicolorous, but darkening gradually towards the margins and posteriorly. Superior claspers of male straight and gradually narrowed, truncate and spinose at the apex. 10. *pallicera*, Big., p. 27.

Group III. (Morsitans Group). Tips of hind tarsi only dark or black (A); or with the tips of all the tarsi dark or black (B). Length $7\frac{3}{4}$–10 mm.

A. Both sexes with the front and middle tarsi yellow. Third segment of antennae long and narrow, apex pointed. Superior claspers in male very similar to those of 12, with a large flange-like projection internally, the breadth of which is greater than the width of the stem of the clasper at the point of its origin.

11. *pallidipes*, Aust., p. 30.

B. Tips of all the tarsi dark or black.

Abdomen often with a large dusky red-brown area; transverse bands on third segment may be either widely separated and faintly indicated medially, or strongly pronounced and narrowly separated. Superior claspers in male terminating in a large tooth-like process on outer angles, the internal flange-like projection much narrower than stem of clasper, and not produced distally into a median lobe.

12. *longipalpis*, Wied., p. 29.

Abdomen with the median stripe usually much wider on the third segment than on the fifth. Median lobes of the superior claspers in male converging distally; outer angle of claspers without any tooth-like process. 13. *morsitans*, Westw., p. 32.

Abdomen with the transverse bands sharply defined medially, median stripe usually of uniform width on the third fourth and fifth segment. Median lobes of the superior claspers parallel; outer angle of claspers without any tooth-like process.

14. *submorsitans*, Newst., p. 33.

Glossina fusca, Walker.

Genital armature of the male (figs. 3 and 4). Superior claspers (*sc*) very widely separated (dorso-ventral view, fig. 4); suddenly rounded apically on the outer lateral margin, the inner lateral margin produced and forming a stout tooth-like projection. When mounted so that an oblique lateral view is obtained the tips sometimes appear to be bluntly bidentate (fig. 3); but the true form of these appendages is that which is shown in fig. 4. Each clasper is clothed dorsally with fine pubescent hairs, and also with a number of very long bristles. The editum, or lappet-like extension of the body wall, is broad and bears a

number of long bristles. The inferior claspers (*ic*) are large; the distal margin is concave, the proximal margin deeply emarginate, hairs long and numerous: the harpes (*h*) have the larger process *strongly serrated along the upper edge* and

Fig. 3.—Male armature of *Glossina fusca*, Walk.; lateral view.

posteriorly to this is a long narrow process; immediately in front of the serrated organ are two additional narrow falciform sclerites, each with the tips curving inwards so that a calliper-like process is formed. Vesica (*v*) somewhat cylindrical,

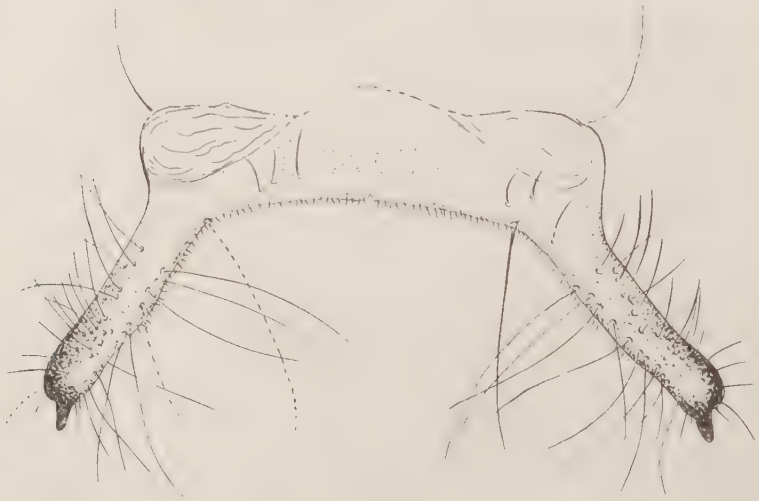


Fig. 4.—Superior claspers of *Glossina fusca*, Walk. ♂; ventral view.

and distinctly membranous in character. Juxta, or penis sheath, membranous, but supported by sclerites on both distal and proximal sides. Median process (*mp*) short and not extending beyond the inferior claspers; upper edge broader than the support, with a deep median depression.

The armature of *G. fusca* may be readily distinguished from those of its allies by the curiously serrated edge of the broad spathuliform portion of the harpes, by the shape of the inferior claspers, and the great width between the superior claspers.

Glossina nigrofusca, Newstead.*

" *Glossina grossa*, Newstead (*nec* Bigot), Ann. Trop. Med. and Parasit., IV, p. 373 (1910).

Glossina nigrofusca, Newstead, l.c., p. 370.

This species is distinguishable from *Glossina fusca* by its generally darker colour, the darker hind tarsi in the male, the narrow lines on the thorax and the strongly pubescent character of the antennae; also in the male armature, by the form of the superior claspers (fig. 5), the large group of squamiform spines (*s*) over the harpes (*h*), and the broad dark sclerite arising from its anterior portion at the base of the vesica (*v*).

Whether the dark colour and the strikingly clear and narrow thoracic markings are constant remains to be seen; the strongly pubescent antennae, however, with their recurved apices, may be taken as fixed characters. The structural characters of the genital armature are markedly distinct from those of the other members of the *fusca* group.

Length, 11–12 mm.; length of wing, 11–11.50 mm.

Thorax very dark brown to blackish brown, with very narrow pale longitudinal stripes, scarcely broader than the pale transverse suture. Abdomen blackish brown, with the second (largest) segment markedly paler. Legs dusky; hind tarsi either all dark, or with the last two segments black, the rest also rather dark but gradually paling proximally; hind and middle femora with a broad infuscated band.

MALE.—*Head* dusky brown to dusky buff; posterior surface dusky grey, sometimes darker towards the upper margins; facial pit grey to ochreous grey; frontal margins shimmering creamy white or yellow white. Antennae with the terminal segment *strongly recurved, and clothed with long pubescent* hairs, the longest hairs on the dorsal edge being equal to about three-fourths the width of the segment. Palpi long and relatively thin, brown with the tips slightly darker. Bulb of proboscis pale, with the proximal portion faintly infuscated. *Thorax* very dark brown to blackish brown, with very narrow pale longitudinal stripes, the submedian ones being generally sharply and clearly defined and scarcely broader than the pale transverse suture; pleurae dark brown. *Abdomen* blackish brown, with the second segment ochreous brown; there is no median stripe on the remaining segments, but a trace of ochreous brown is faintly visible on the third, fourth and fifth; lateral margins of all the segments narrowly paler than the rest; venter dusky ochreous; sides of the third, fourth and fifth segments and also the hypopygium infuscated; stigmata white.

* See foot-note on p. 9.

Legs yellowish brown or buff: femora broadly and distinctly infuscated, especially the middle and hind pair. Middle and hind tibiae also with a very broad infuscated blotch; anterior tarsi with the tip of the fourth segment black, last segment dark at tip but not black; middle tarsi similar; hind tarsi all dark, but the distal half of the third segment and the whole of the two succeeding ones black; hairs on ventral surface bright golden brown.

Female. Differing from the male in having the legs decidedly paler: the hind tarsi with the last two segments black, the second and third with the tips only black. The thoracic and abdominal markings and also the form and strongly pubescent character of the long terminal segment of the antennae are specifically the same as in the male.

Described from four examples, three males and one female. One male was taken at Kasongo, Congo Free State, 6. II. 04 (*Drs. Dutton* and *Todd*): another at Sunyani, Ashanti, 5. III. 10, and the third at Atroni, W. Ashanti, 16. VIII. 10 (*Dr. A. Kinghorn*): the only female I have yet seen was taken at Odumase, W. Ashanti, 27. IV. 10 (*Dr. A. Kinghorn*).

Genital Armature of the male (fig. 5). Superior claspers (*sc*), free and strongly bidentate: bristles long and slender; proximal half of the dorsal surface clothed with finely-pubescent hairs. The editum or extension of the

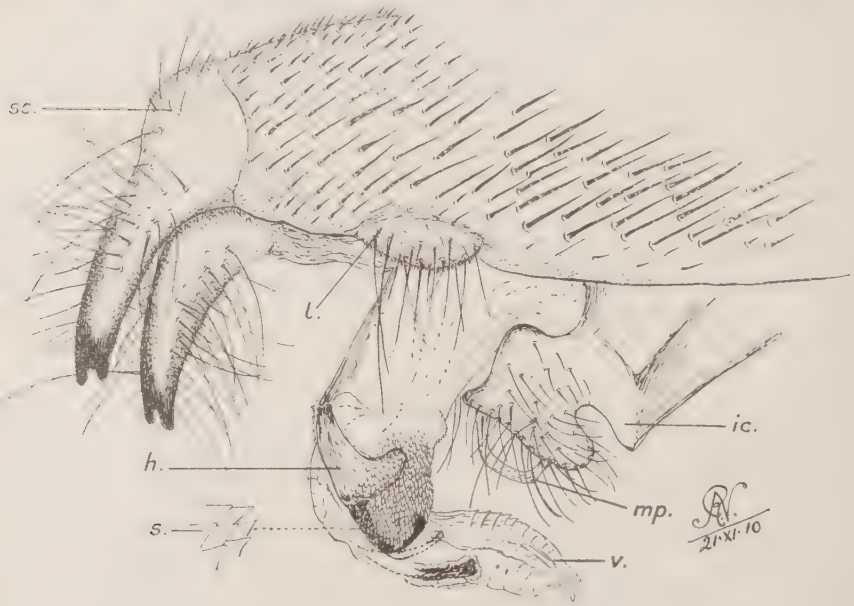


Fig. 5. Male armature of *Glossina nigrofusca*, Newst.; lateral view.

body-wall (*l*) with relatively few bristles, the longest reaching to the base of the harpes; some of the bristles are broken or entirely wanting, and it is highly probable that some of these may prove to be longer than those shown in the illustration. Inferior claspers (*ic*), clothed with numerous long hairs; distal margin presenting an ogee curve, the base being strongly and broadly produced, the distal angle narrowly produced and narrowly rounded; proximal margin with a very deep and somewhat elliptical emargination. Median process (*mp*)

relatively short, with a broad band-like upper surface. Harpes (*h*) protected by a thin membrane which is clothed with small squamiform spines: as far as one can ascertain by an examination of the armature in optical section, these spines are not attached to the harpes, as they are seen to extend beyond them on the thin mantle-like wall which completely envelopes the penis sheath; the terminal process of the harpes lies concealed beneath the squamose spines in one instance: in another specimen it projects beyond them as shown by dotted lines in fig. 5; it is somewhat falciform in shape, and formed of black chitin. Vesica (*v*) with a broad and apparently detached sclerite on the ventral surface; upper or proximal surface with several distinct transverse folds, presenting at the edge a distinctly serrated appearance.

Glossina brevipalpis, Newstead.

G. brevipalpis, Newst., Ann. Trop. Med. and Parasit., IV., p. 372 (1910).

This tsetse-fly is easily recognised from the two western representatives of the *fusca* group (*G. fusca* and *G. nigrofusca*) by its shorter and stouter palpi, its more robust form, and the generally paler colour and somewhat indefinite thoracic markings; and again in the morphological characters of the male armature (figs. 6, 7), by the great length of the median process (*mp*), the presence of the long bilateral row or band of squamose spines (*s*), and in the form of the harpes.

Length, 10–12 mm.; length of wing, 11–11½ mm.

Thorax pale to dark brown, with greyish-brown longitudinal stripes and markings, often more or less obscure. Abdomen dark brown to smoky brown: second segment rarely much paler than the others. Legs ochreous brown; tips of middle and hind tarsi black; anterior tarsi generally without dark tips. Palpi relatively short and stout.

Male. *Head* with the front uniformly pale ochreous brown, frontal margins brighter; eyes slightly converging. Antennae pale ochreous with the anterior half infuscated: arista infuscated at the base. Palpi relatively short and stout. *Thorax* dark brown, with the markings dusky grey-brown: these vary in intensity but are usually more or less indefinite. *Abdomen* dark brown; second segment scarcely paler than the others; margins and posterior angles sometimes narrowly paler. *Legs* pale ochreous brown; last two segments of middle and hind tarsi dark, blackish; last two segments of front tarsi either with or without brownish tips; front femora infuscated dorsally and slightly also internally: hind tibiae with a more or less distinct infuscated band; venter, in examples which have not partaken of a meal of blood, pale ochreous brown, margins of the third to the sixth segments infuscated; stigmata dusky ochreous.

Female. Colour and pattern closely resembling that of the male, but with the hind and lateral margins of the abdomen sometimes more strongly pronounced.

Type ♀ Songwe River, N. Nyasa 7. I. 09 (*Dr. J. B. Davey*). Co-type males from near Kaporo, N. Nyasa, 5. VIII. 09 (*Dr. J. B. Davey*).

Genital armature of the male (figs. 6 and 7). Superior claspers (*sc*) free and strongly and bluntly bidentate; they are also narrowly separated when fully extended (fig. 7); bristles on the inner surface much longer than those on the outer

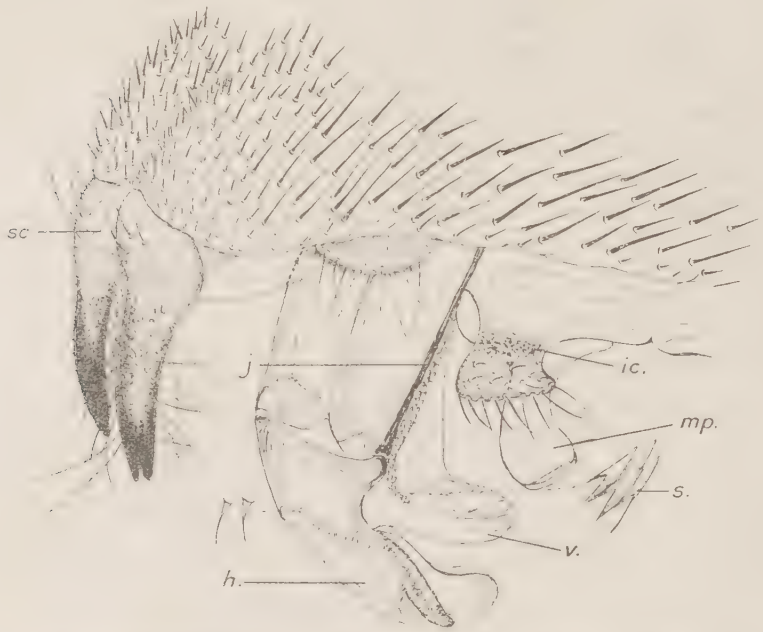


Fig. 6. Male armature of *Glossina brevipalpis*, Newstead ; lateral view

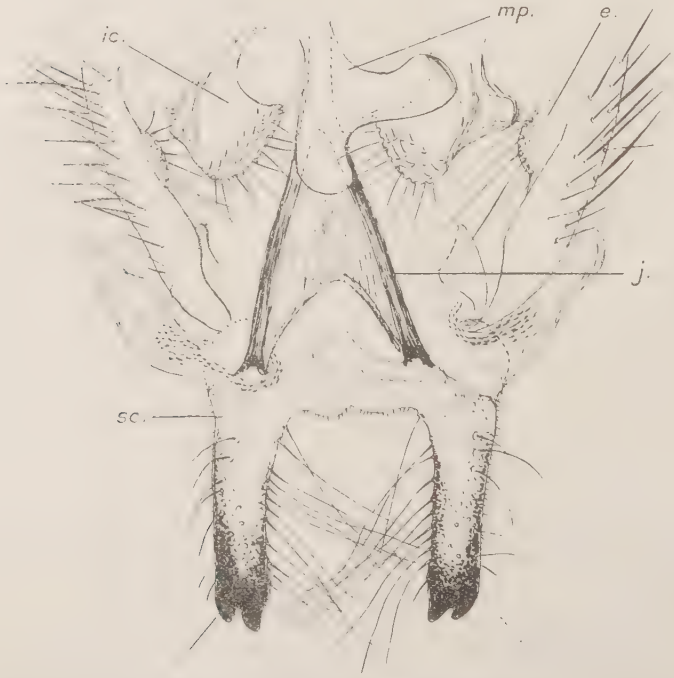


Fig. 7. Male armature of *Glossina brevipalpis*, Newstead ; ventral view.

lateral margin. Editum or extension of the body wall (*e*) with very few bristles. Inferior claspers (*ic*) relatively small and narrowed basally on both sides; bristles at the sides short. Median process (*mp*) a little more than twice the length of the inferior claspers, gradually dilated towards the apex and of a clear horn-yellow colour: it is so highly chitinised as to resist the action of stains, and stands out in marked contrast to the surrounding organs; it is also so large that it can be seen with the aid of a pocket lens only. Harpes (*h*) with the tips of the larger process broadly dilated; there is also a long narrow and slightly curved sclerite overlapping the broader process: these appendages are partly covered by the thin membrane which protects and envelopes the penis-sheath; extending obliquely across the harpes is a band of minute spines which are strongly dilated proximally. On the proximal surface of the juxta is a bilateral row of squamose spines (*s*). The juxta in dorso-ventral view (fig. 7, *j*) presents a distinctly elongated, triangular outline; but in profile (fig. 6) only one of the lateral sclerites (*j*) forming the juxta is visible in the same focal plane as the harpe.

Glossina longipennis, Corti.

Genital armature of the male (fig. 8). Superior claspers (*sc*) free, as in the other members of the *fusca* group; relatively short and stout, apices rather

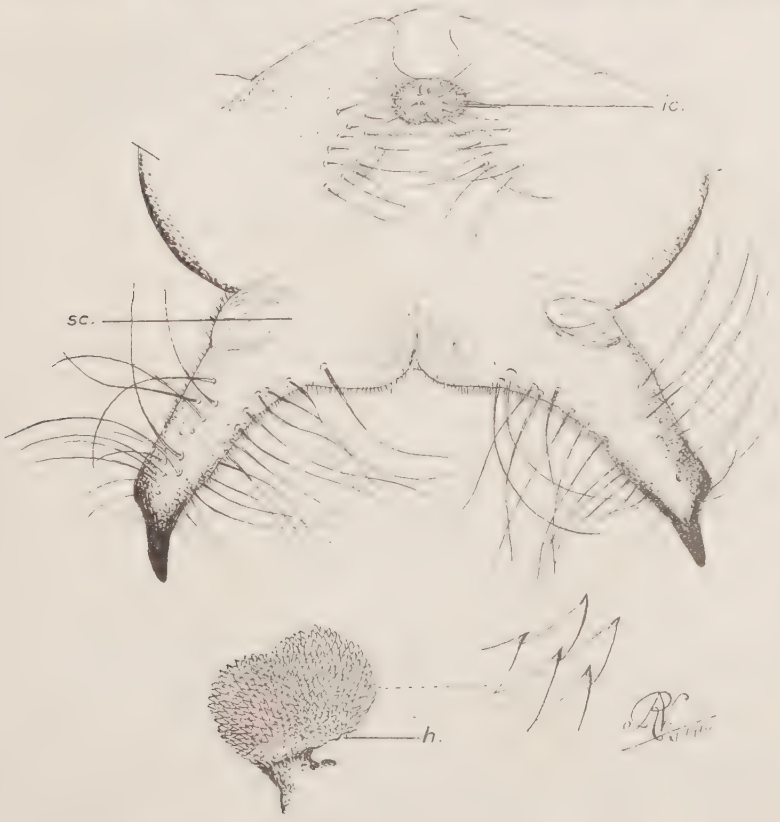


Fig. 8. Male armature of *Glossina longipennis*, Corti; ventral view.

gradually attenuated and falciform; bristles very long on both sides, and the pubescence extending to the dark chitinous portion near the apex. Inferior claspers (*ic*) relatively very small, and narrowly rounded apically; they are also placed much nearer the articulation of the hypopygium, and as seen in the dorso-ventral position (fig. 8, *ic*) the tips overlap so that a dark ovoid area is presented; bristles long and slender, extending considerably into the broadly dilated or proximal portion. Harpes (*h*) with the larger process broadly bilobed and completely covered with large squamose spines.

Unfortunately the only two preparations in our possession are mounted so as to give a dorso-ventral view, and in this position it is impossible to give further details of the other morphological characters. Be this as it may, the species is markedly distinct from the other tsetse-flies belonging to this group, and, apart from the spotted character of the thorax, the males of *Glossina longipennis* may be easily distinguished by the curious squamiform harpes, and the position of the relatively small and overlapping inferior claspers. So soon as fresh material comes to hand further details will be given, together with drawings of the armature in profile, so that they may be compared with those of the other members of the *fusca* group.

Glossina maculata, Newstead.

The type and only known example of this insect is unfortunately a female; otherwise I would sacrifice it so that its specific identity could be more definitely established. It is nearly related to *Glossina palpalis*, but in its colour and pattern is so markedly distinct as to be recognised from the latter without any difficulty. It has been suggested that the characteristic dusky spots are due to secretion from other flies which were enclosed in the same packet. This interpretation I cannot accept, as the spots are not due to any such foreign matter.

Glossina palpalis, Rob.-Desv.

Genital armature of the male (fig. 9). Superior claspers (*sc*) widely separated and connected by a membrane (*cm*); distal extremity suddenly attenuated and tooth-like; there are numerous long bristles on both sides of each clasper, but those on the inner lateral margin gradually shorten towards the apex; there is usually one rather long bristle near the base of the tooth-like projection. Connecting membrane (*cm*) deeply divided centrally, and not nearly reaching the tips of the claspers; it is partly covered on both sides by minute spines. Editum (*e*), or lappet-like extension of the body wall, with relatively short bristles, the longest of which extends midway between the edge of the editum and the juxta. Inferior claspers (*ic*) broad and spinose basally; apices greatly extended, the extension taking the form of a long leg-like process with a suddenly dilated extremity, shaped somewhat like a human foot, and furnished with a few minute spines along its lateral margin; these appendages are deeply folded basally (not shown in figure), and on either side is a relatively large beak-like extension, often apparently a folded extension of the clasper. Harpes (*h*) represented by minute narrow curved strips of chitin which curve upwards so that the ends in some instances almost touch the lobe-like extensions of the

juxta. Vesica (*v*) minute and rudimentary. Juxta or penis sheath (*j*), relatively narrow, the upper surface represented by two strips of chitin, which curve outwards distally, their apices being distinctly lobe-like; basally these strips meet and form a single tube. On either side of the juxta is a short tubular process, and attached to the lower or distal opening of this is a folded membrane which is thickly studded with minute spines.

Fig. 9. Male armature of *Glossina palpalis*, R. D.; ventral view.

The most marked character of the armature of this tsetse-fly is the curious form of the inferior claspers, and this is the only structure in which it differs specifically from the armature of the male of *G. tachinoides*.

Glossina palpalis var. wellmani. Austen.

A large series of preparations of this variety has been examined microscopically, with the result that the genital armature has been found to be quite identical with that in typical examples of *G. palpalis*. This form is distinguished from normal *G. palpalis* by its smaller size and slightly different thoracic markings. These differences, however, are not sub-specific, but merely varietal in character, for the var. *wellmani* occurs in company with the typical form in various localities, and in a good series every intergrade can be found.

Glossina caliginea, Austen.

Genital armature of the male (fig. 10).—Superior claspers (*sc*) curving inwards and calliper-like; tooth at distal extremity very long and falciform, the length nearly equal to one-third the length of the clasper, strongly curved ventrally as well as laterally, so much so that its actual length is difficult to determine when viewed dorso-ventrally as shown in the illustration; remaining portion of clasper very broad and flattened dorso-ventrally; inner lateral bristles long but shortening

gradually as they approach the base of the falciform tooth, from which there arises a single bristle of much greater length than the rest; median group of bristles very long. Connecting membrane divided medially as in the other members of this group. Inferior claspers (*ic*) gradually attenuated, distally forming a leg-like extension terminating in a foot-like process bearing three or four slender and relatively long hairs: basal portion densely clothed with long bristles. Editum (*e*) rather large; bristles not reaching beyond the middle of the inferior clasper. Harpes and penis-sheath similar to those in *G. palpalis*; vesica with two inwardly curved sclerites, the apices of which meet in the middle line; distal portion membranous.

Fig. 10.—Male armature of *Glossina caliginea*, Austen.

Lying immediately in advance of the apex of the inferior claspers is a short chitinous cylindrical tube (*ap* 1), the outer wall of which is extended backwards or proximally, forming a long band-like sclerite which is apparently connected with the inferior clasper; attached to the circular orifice of the short tube is a very long, narrow, membranous sac or vermiform appendix (*ap*) bearing upon its exterior surface a number of minute spines arranged more or less in transverse rows. This organ has been observed in other species of *Glossina*; in no other

instance however has it been found fully extended, but in all cases it was seen lying in a folded and contorted position similar to that which is shown in fig. 10 on the right side of the illustration (*ap*).

Though closely related to *G. palpalis*, the armature of the male may be easily determined by the great length of the falciform or claw-like extensions of the superior claspers; the inferior claspers are also much more gradually attenuated and the toe or apex of the foot-like process is furnished with three or four small hairs. There are also other minute differences such as the form of the vesica and the juxta, but the most marked morphological character is the great length of the tooth-like extension of the superior clasper which gives this structure a very distinct and marked character.

Glossina tachinoides, Westwood.

Genital armature of the male (fig. 11).—Superior claspers (*sc*) united by a membrane; in shape they are identical with those in *Glossina palpalis*, but are

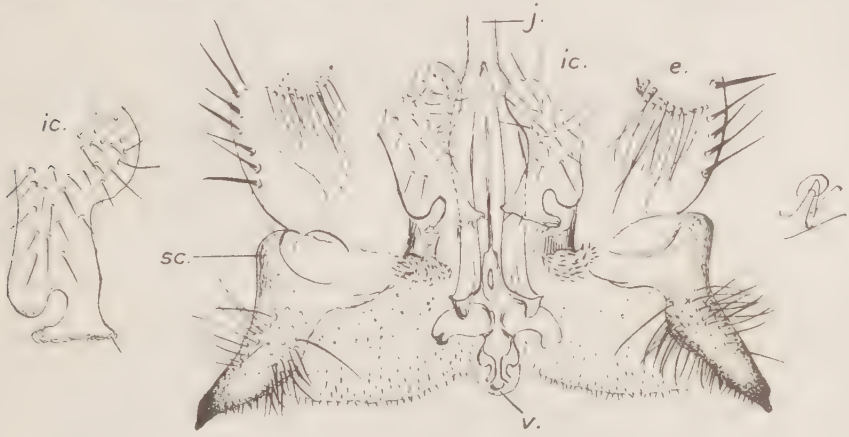


Fig. 11.—Male armature of *Glossina tachinoides*, Westw.; ventral view.

relatively smaller. Connecting membrane (*cm*) spinose on both surfaces, and deeply divided centrally. Inferior claspers (*ic*) with the inner lateral margin proximally produced and broadly rounded: beyond this prominence the process is broad and parallel-sided: the outer lateral margin at the distal extremity is suddenly rounded and deeply emarginate; the inner lateral portion being extended into a foot-like process on the edge of which are two or three minute hairs. The editum (*e*), the harpes (*h*) and the vesica (*v*) are all specifically identical with the corresponding organs in *G. palpalis*; and although these organs respectively may appear to differ slightly in the illustrations, the differences are simply due to the orientation in the mounted preparations.

It may be readily seen on comparing the figure of *G. tachinoides* with that of *G. palpalis* that the morphological characters of the species are almost identical; the only salient characteristic being the curious form of the inferior claspers in *G. tachinoides*, which will at once serve to distinguish the male of this tsetse from the male of *G. palpalis*.

Glossina fuscipes, Newstead.

G. fuscipes, Newst., Ann. Trop. Med. and Parasit., IV, p. 375 (1910).

This tsetse-fly may be readily distinguished from *G. palpalis*, by its much smaller size, by the uniformly infuscated or dusky legs, and the dusky grey thorax. In size it resembles *G. tachinoides*, Westw., but it is a relatively stouter built insect; and altogether it is most like a dwarfed specimen of *G. palpalis* with infuscated legs and dusky thorax. The genital armature resembles those of *G. palpalis* and *G. tachinoides* in its general form; but the superior and inferior claspers are quite distinct from those of either of these insects.

Length, 7½ mm.; length of wing, 8 mm.

MALE.—*Head* with the frontal stripe yellowish brown, margins dusky white; ocellar triangle buff, enclosing a very dark brown spot. Antennae grey; arista dark brown ventrally. Palpi smoky brown with a paler narrow median line. Proboscis with the bulb dark piceous. *Thorax* with a median dark grey rectangular area extending from the front to the scutellum, the sides of which are perfectly straight and parallel; on either side of the grey area are two greyish black and somewhat triangular blotches, evidently remnants of those found in other species of *Glossina*; scutellum dark grey with a very faint pale grey median line, margins buff; sides of the lateral thoracic depressions dark brown or almost black; pleurae dark grey. *Abdomen* resembling that of *G. palpalis*, but the transverse banding somewhat pronounced; lateral margins with pale angular areas. *Legs* strongly and almost uniformly infuscated (dark or smoky grey); femora with the basal and inferior portions ochreous buff; hind tarsi all dark brown or almost black. *Wings* with the anterior transverse vein strongly and suddenly incrassate at its junction with the third longitudinal vein.

Genital armature of the male (fig. 12). Superior claspers (*sc*) sub-cheliform: suddenly curved inwards distally, at a point about two-thirds of the distance from the base, so suddenly on the outer margin as to present an almost angular or elbowed appearance; distal extremity furnished with a strongly curved tooth or claw-like process, *the constriction being on the inner lateral margin*; proximally they are rather broad and have a distinct beak-shaped base, the apex of which points inwards; bristles relatively short, those on the inner lateral margin more spinose in character and attached to transparent chitin. Inferior claspers (*ic*) very broad with a large and almost circular emargination on the outer lateral margin, distally; stem of the foot-like extension slightly curved inwards, the terminal portion relatively narrow and bluntly pointed. Chitinous walls of the vesica (*v*) with a few squamose spines; it is possible that these form the rudimentary harpes. Connecting membrane as in other members of this group. The juxta, vesica and some other organs became displaced in the process of mounting the armature, so that they lie in an asymmetrical position and present a somewhat peculiar aspect as may be gathered from the illustration.

The only example which we possess of this small tsetse-fly was taken by Dr. J. O. Shircore, and was forwarded with a letter dated from Nimule, Nile Province, Uganda. Fortunately it proved to be a male otherwise it might have been passed over as a small dusky form of *Glossina palpalis*.

In a more recent communication Dr. Shircore states: —" I think it must be different from *G. palpalis*. I have seen so many specimens of *G. palpalis* and this fly side by side; and especially round Nimule, they are constantly found in certain places with the larger *G. palpalis*. The difference in size in fresh specimens is very noticeable. The *G. tachinoides** is found chiefly along the course

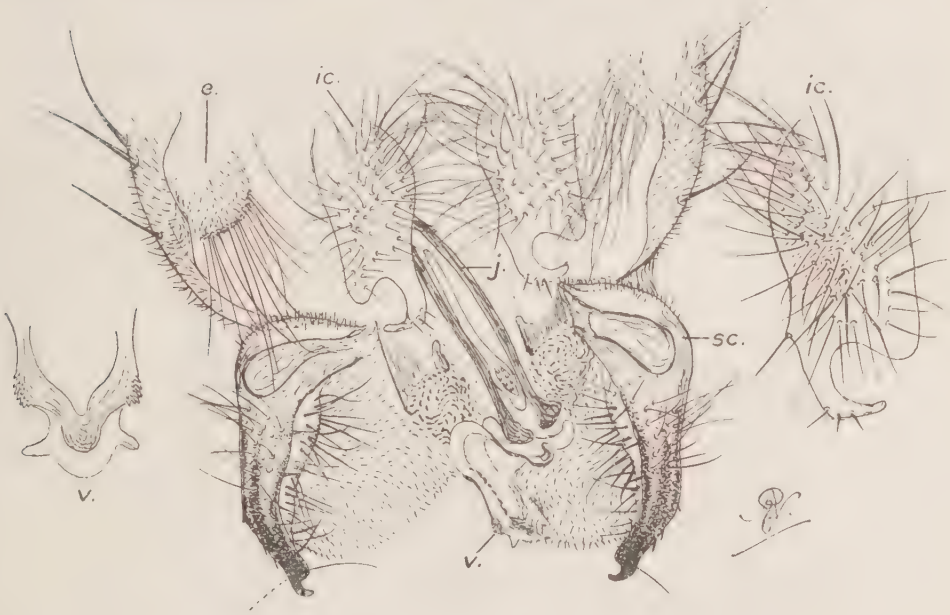


Fig. 12.—Male armature of *Glossina fuscipes*, Newstead; ventral view.

of very rocky streams, whereas the large one occurs along streams of quite a different character. Dr. Wiggins to whom I showed the fly inclines to my view that it is certainly different from the ordinary *G. palpalis*; as also does Dr. Mackie, of the Sleeping Sickness Commission, who was out here with Sir David Bruce."

Glossina pallicera, Bigot.

Genital armature of the male (fig. 13). Superior claspers (*sc*) united by a membrane; base of clasper four times broader at the base than at the distal extremity, with the inner basal portion extended inwardly so that it comes very near to the juxta; outer basal portion broadly rounded and with a broad curved and somewhat attenuated process, the tip of which rests upon the inner basal process; this portion of the clasper is clothed with fine pubescent hairs; margins gradually tapering distally; apex suddenly truncate, the inner half bearing a few short spines; bristles on the inner lateral margin gradually shortening distally, those on the outer lateral margin few in number, some of which are

* Dr. Shircore apparently has an idea that the species in question is *G. tachinoides*.—R.N

slightly longer than the longest on the opposite side of the clasper. The connecting membrane (*cm*) deeply divided and spinose on both sides. Harpes somewhat S-shaped, the distal portion being much broader and flatter than the proximal. Juxta (*j*) very similar to that in *G. palpalis* and *G. tachinoides*. Inferior claspers (*ic*) with a number of bristles on the broad basal portion, their apices somewhat falciform, being curved outwards and apparently bluntly pointed; but their true morphological character cannot be exactly ascertained as the terminal portion presents an oblique view in the only specimen examined; they are however specifically distinct from the corresponding organs in the other known species of tsetse-flies. Editum (*e*) with the longest bristles reaching almost to the proximal portion of the superior claspers.

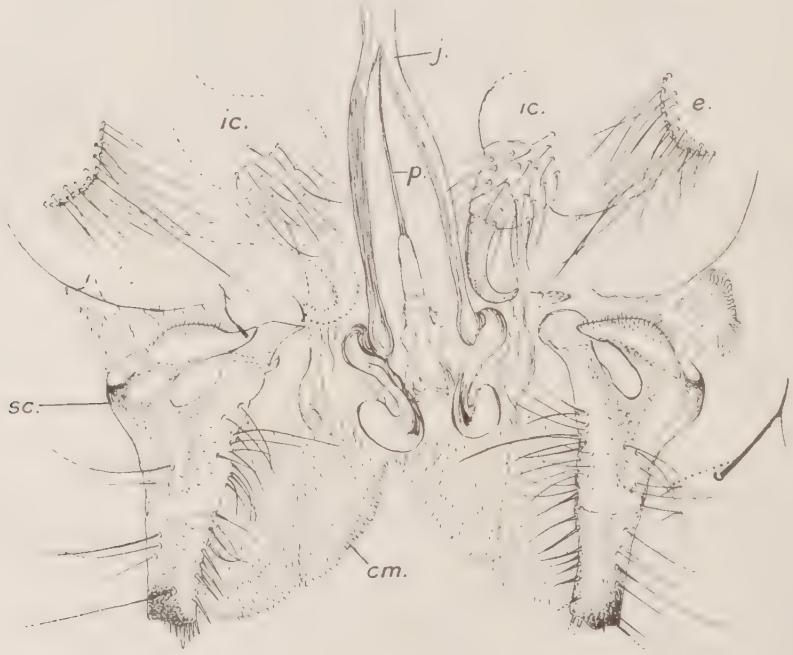


Fig. 13.—Male armature of *Glossina pallicera*, Bigot; ventral view.

I have been able to examine but a single example of the male armature of this insect, so that it is just possible that other characters may in future be discovered. One cannot be at all certain for instance as to whether the outer half of the distal extremity of the claspers will invariably present the suddenly truncate or broken appearance as exists in the specimen described: it is obvious, however, that the inner half of the apical margin is perfect and intact, as the presence of the spines amply testifies.

The distinctive morphological features are: the great width of the claspers proximally and the presence of the short spines on the distal margin: the curious and somewhat falciform shape of the inferior claspers and the striking form of the harpes.

It may be interesting to add that there are some curiously malformed bristles present upon the right clasper (see fig. 13); these give off a fine lateral hair towards the apex the tip of which points backwards, so that a reversed bifurcation is produced. This striking malformation is not peculiar to this tsetse-fly as similar instances have been observed in *Glossina submorsitans* and also in other species of the genus.

Glossina longipalpis, Wiedemann.

Genital armature of the male (figs. 14, 15A). Superior clasper (*sc*) completely united by a membrane and also fused medially; base narrower than the greatest width of the distal portion; general outline broadly spathuliform; stem in its narrowest portion about one third the width of the distal portion; distal margin, on the outer lateral portion, with a large tooth-like extension; the remaining

Fig. 14.—Male armature of *Glossina longipalpis*, Wied.; ventral view.

portion broadly rounded and furnished with a closely set series of stout spines, the smallest arising from near the base of the tooth-like projection; these gradually lengthen as they extend towards the base of the clasper; bristles on the outer lateral half unusually long, being equal to three-fourths the entire length of the clasper; there is also a single, but shorter bristle arising from the base of the tooth-like projection which curves outwards and inwards in the same way as has been observed in the corresponding bristles found in *G. morsitans* and *G. submorsitans*; each clasper has also a thin but strongly chitinised flange-like extension which meets the one on the opposite clasper with which it is apparently fused, though a faint straight suture is visible between them; this process extends to the widest portion of the claspers where it terminates suddenly and sometimes presents a small median emargination; but there are no lobe-like extensions as in *G. morsitans* and *G. submorsitans*. The dorsal surface of this

flange is furnished with several rather large spines. Editum (*e*) with a large number of very long bristles, the longest of which extends beyond the middle of the superior claspers. The inferior claspers are so contorted and folded that so far it has been impossible to interpret their true character: one can only say that they are provided dorsally with bristles of great length In all probability they may be seen best when mounted in profile but at present we have no more material available for examination.

The remarkable and unique form of the claspers will, however, enable the student readily to distinguish the males of this tsetse-fly from any of the other known species. Fourteen examples have been examined.

Glossina pallidipes, Austen.

Genital armature of the male (fig. 15). Superior claspers in their general form closely resembling those of *G. longipalpis*, but the stem is relatively broader and the broad distal portion is much more rounded and produced inwardly. The single hairs on the distal or posterior margin are generally very short and

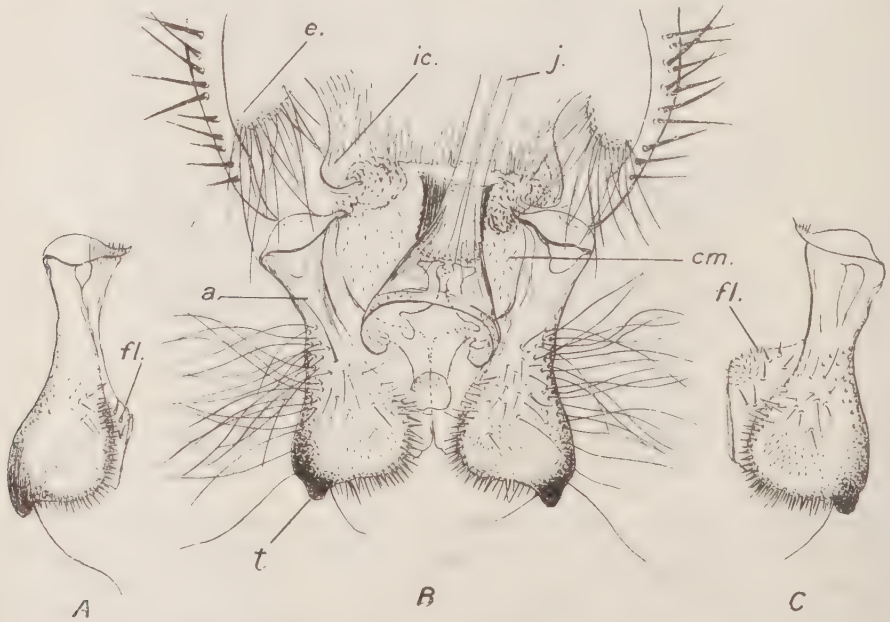


Fig. 15. Male armatures of *Glossina pallidipes*, Aust, and *G. longipalpis*, Wied.
A. Left superior clasper of *G. longipalpis*. B. Entire armature of *G. pallidipes*.
C. Right superior clasper of *G. pallidipes*.

slender, but the length varies somewhat and occasionally they are asymmetrical, but in no single instance have they been found sufficiently long to overlap or meet in the median line. Posterior lateral tooth (*t*) set in slightly from the outer lateral margin; each clasper has a thin but strongly chitinised flange-like extension which meets the one on the opposite side so that a fine straight median suture is formed; this flange-like extension (C, *fl*) commences near the centre of

the stem of the clasper and takes a course almost at right angles to the latter until it reaches the middle line, when it bends suddenly towards the distal margin of the claspers so that a large rectangular projection is formed, the breadth of which is greater than the width of the narrowest portion of the superior clasper: bristles on the outer lateral portion similar to those in *G. longipalpis* but relatively shorter. Juxta (*j*) with a very narrow slit on the distal portion. Bristles of the editum (*e*) half the length of the superior claspers. Inferior claspers (*ic*) pointed, basal portions very broad and apparently meeting in the median line.

The morphological differences between this species and *G. longipalpis*, though they may appear at first very slight, are really well marked and pronounced, as may be gathered from the following table and the accompanying illustrations :—

Comparative Table of the Morphological Characters of the Superior Claspers, &c., of G. pallidipes *and* G. longipalpis.

	G. longipalpis.	*G. pallidipes.*
Heel or posterior lateral tooth.	Outer lateral margin taking same contour as the margin of the clasper.	Outer lateral margin generally curved inwards.
Single long hair on distal margin.	Long and capable of overlapping corresponding hair on opposite clasper.	Short and not capable of overlapping hair on opposite clasper.
Inner flange-like extension of superior clasper.	*Greatest breadth about one-fourth* the width of the narrowest portion of stem.	*Breadth greater than the width of the narrowest portion of the stem.*
Longest hairs of editum.	Equal in length to the superior clasper.	One-half the length of the superior clasper.

In the paper recently published by me in the Annals of Tropical Medicine and Parasitology (Vol. IV., p. 370) I called attention to the fact that I had examined a single example of what had been considered an authentic specimen of *G. pallidipes*, Austen, and that it proved to be morphologically identical with *G. longipalpis*, Wied. In the light of this discovery I felt that the only course open to me was to treat *G. pallidipes* as a colour variety of *G. longipalpis*. The specimen in question has, however, proved to be a variety of the latter with pale front and middle tarsi, so that this insect is evidently given to occasional variation in the colour of the tarsi, though at the present moment this would seem to be an isolated instance.

Thanks to the kindness of Mr. E. E. Austen, of the British Museum of Natural History, I have been able to examine the genitalia of seven males of his *G. pallidipes*,* and it was by the examination of this material that

* All labelled from "Machakos, B. E. Africa. Presented by Tsetse-Fly Committee of the Royal Society per Lt.-Col. Bruce."

the morphological differences were found to exist. I am delighted therefore to be able to refute the statement previously made by me (*l.c.*) and to express my indebtedness to Mr. Austen for so generously placing the specimens at my disposal.

Glossina morsitans, Westwood.

Genital armature of the male (fig. 16). Superior claspers (*sc*) completely united dorsally by a thin membrane which is thickly studded with minute spines: form somewhat like the scapula of a mammal; each clasper is furnished on the inner lateral margin with a strip of pale chitin which *curves outwards and touches*

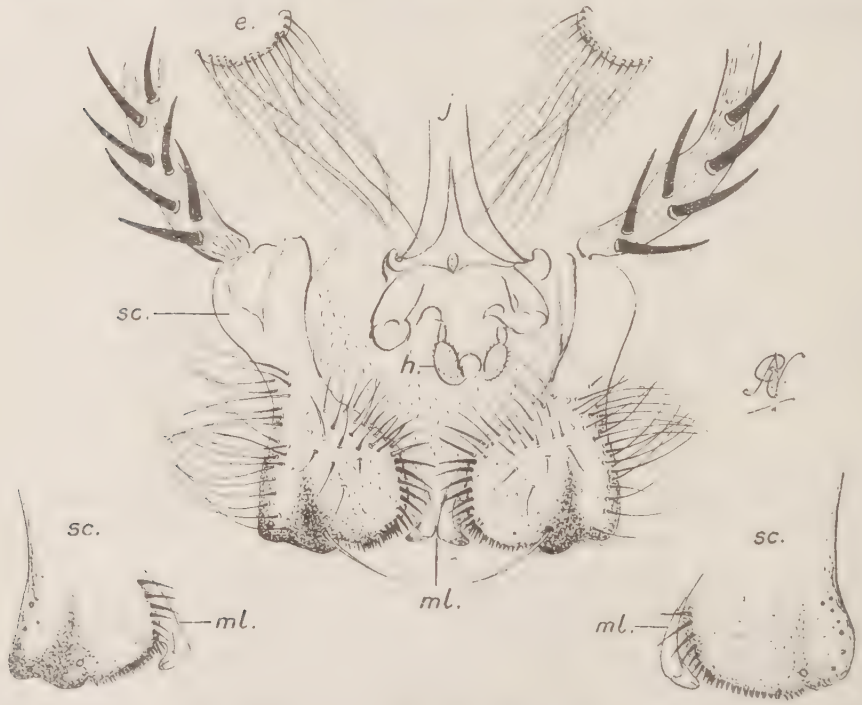


Fig. 16. Male armature of *Glossina morsitans*, Westw.; ventral view.

the process on the opposite side near the distal extremity only; apices divergent, forming a recurved lobe-like extension (*ml*); inner lateral group of hairs usually relatively shorter than the corresponding group in *G. submorsitans*: these hairs gradually shorten distally and finally merge into strong black spines, the latter also gradually shortening distally and becoming quite minute on the posterior or distal margin. There is a single long hair which has its origin within the margin near the centre of the median process; in the figure this bristle is shown projecting beyond the clasper and is, in all probability, in its normal position, though in a number of examples it lies pointing towards the proximal portion of the claspers. Harpes (*h*) small, spinose, curved upwards and rounded at the tips; basal process also curved upwards and presenting no very definite form. Vesica, or median process, very small and broadly rounded. Juxta (*j*) broadly

dilated distally; lips reflexed; editum (*e*), or lappet-like extension of the body wall, with numerous long hairs. Apart from the form of the superior claspers there is no marked difference between the armature of this species and that of *G. submorsitans*.

Sixty-five examples have been examined.

Glossina submorsitans, Newstead.

G. submorsitans, Newst., Ann. Trop. Med. and Parasit., IV, p. 371 (1910).

Nearly related to *Glossina morsitans*, Westw., in having the tips of all the tarsi dark. There are two well-marked varieties: a dark form and a light form. The former may be readily distinguished by its general dusky or dull vinous grey colour and generally smaller size: the pale form, however, very closely resembles *G. morsitans* in the general colour of the abdomen; but in both forms the transverse black abdominal bands are:

(a) much more clearly and sharply defined;
(b) equally and more narrowly interrupted in the median line on the third, fourth, and fifth segments;
(c) slightly rounded medially and suddenly tapering towards the lateral margins.

In *G. morsitans* the bands are:

(a) not so sharply defined medially;
(b) unequally interrupted in the middle line, the space between the two divisions of the band on the third being much greater than the space between those on the fifth segment; and the dark colour gradually shading off into the pale colour forming the median line;
(c) broadly rounded medially and very gradually tapering towards the lateral margins.

The genital armatures of the males of these two species are easily separable by the form of the median lobes (figs. 16, 17, *ml*) and other characters (*see* p. 36).

Length, 7 to 8 millim; length of wing, 7 to 8 millim.

Dark Form.—*Head*. Frontal stripe smoky brown or red brown to ochreous, ridges paler; cheeks clothed with greyish dust: jowls clothed with long white hairs: roof of buccal cavity with two more or less angular patches of brown. *Antennae* dusky ochreous grey to pale red-buff, sometimes infuscated at the tip: arista with the proximal ventral portion dark brown. *Palpi* greyish buff: usually cinereous above, apical portion infuscated, tips usually black. *Thorax* grey, often with a faint vinous tinge, the elongated brownish markings sometimes reduced to small and more or less elongated spots: scutellum normal: pleurae ochreous grey. *Abdomen* olivaceous grey (greenish grey), generally with a vinous tinge, paler at the margins: second (first visible) segment generally with a large infuscated blotch on each side, near the outer lateral margin of which is a clearly defined small blackish brown spot: in some instances the small spot is quite separated from the infuscated blotch, in others the small spot only is visible: segments 3 to 6 with clearly defined brownish black bands interrupted

in the middle by the olivaceous grey, or grey, ground colour, the latter forming a continuous median stripe : the dark bands occupy the basal two-thirds of each segment, they taper towards the lateral margin but their inner margins are almost straight. *Legs* varying from pale buff to dusky buff : front femora inside, the middle and hind pair on the outside, more or less infuscated ; front and middle tarsi with the last two segments black at the tips ; last two segments of hind tarsi entirely black. *Wings* normal ; halteres pale yellowish, translucent.

Types ♂ ♀ (Coll. British Museum) Katagum River, between Katagum and Geidam, Northern Nigeria (Dr. F. W. McKay).

Pale Form.—*Thorax* with markings similar to those in the dark form, but the pleurae generally paler. *Abdomen* greyish buff, with a pale vinous tinge : blackish bands very sharply and clearly defined and narrowly interrupted in the median line ; those on the third, fourth and fifth segments being equally separated : the bands are also only very slightly rounded medially and rather suddenly so towards the lateral margins. *Legs* as in the dark forms.

Two co-type males and a female (Coll. Brit. Mus.) were captured by Dr. A. Kinghorn at Sabiya-Bofe, Northern Ashanti, 24.IV.10. Eight additional specimens were also captured by Dr. Kinghorn in various localities in Ashanti all of which have pale abdomens.

Genital armature of male (fig. 17).—Superior claspers (*sc*) very like those of *Glossina morsitans* : width of distal margin nearly three times that of the narrowest

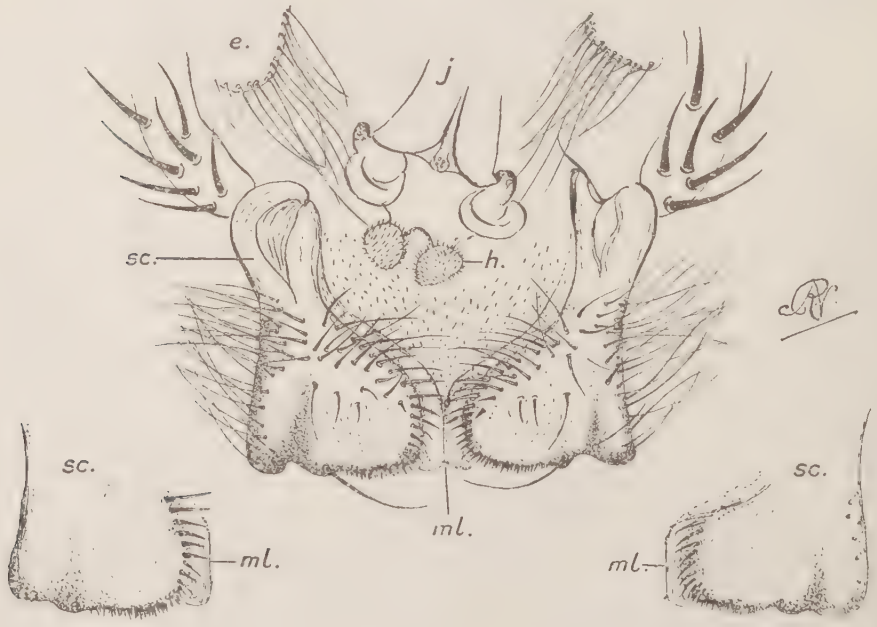


Fig. 17.—Male armature of *Glossina submorsitans*, Newst. ; ventral view.

portion of the stem ; each clasper is furnished, on the inner lateral margin, with a broad parallel-sided strip of pale chitin the tip or distal extremity of which is

somewhat triangular in shape, and turned outwards, forming, with the one on the opposite side, a median lobe-like projection (*ml*): on the outer margin of each of these appendages, near the base of the curved portion is a minute tubercular process: this curious little structure is evidently moveable as in many instances it is seen lying concealed in a cavity extending distally from its base: in some instances both are seen to lie in a recumbent position: in other examples either one or both may stand erect at right angles to the basal attachment. The heel or posterior lateral angle is normally somewhat strongly produced and narrowly rounded: but in two examples (shown separately in fig. 17) this process is more broadly rounded; and in one instance it does not extend distally as far as the sub-median process; the latter is never so prominent as it is in *G. morsitans*, and *immediately within its margin* is a long bristle which in the majority of specimens lies upon the surface of the clasper with its point towards the proximal or basal portion: but for the sake of clearness it has been figured as seen in some few instances; outer lateral margins concave and furnished with a series of very long slender bristles or hairs, becoming more numerous proximally and shortening gradually as they extend across the flat portion, finally merging into those which extend along the inner lateral margin. These are again succeeded by short black spines which project over the median processes: these black spines also gradually diminish in size and merge into the minute ones extending along the posterior or distal margin as far as the submedian process. The most marked feature of the claspers is their general angular outline and the somewhat straight-cut appearance of the posterior margin: these characters taken together with the form of the median pair of processes will serve at once to distinguish the genitalia of this insect from those of *G. morsitans*, and with a little practice the species may be separated unerringly by the aid of a lens having a magnification of 20 diameters only. Inferior claspers small and covered with minute hairs; these together with the juxta (*j*) and its appendages and also the harpes (*h*) are practically identical with the corresponding organs found in *G. morsitans*.

It may be well to note that this insect has a marked tendency to become 'greasy,' so that all trace of colour disappears. Dr. Macfie has also noticed the same tendency and says, in a letter, dated 7th October, 1910, Minna, Northern Nigeria, "When I was at Baro last September, on Sleeping Sickness duty, I noticed one day (September 11th, 1910) that there were two distinct forms of what I supposed to be *G. morsitans*—the one dark, the other pale. The difference was quite noticeable when the flies settled on the 'boys'' coats, and I was able to catch specimens of each variety. Unfortunately all my own specimens were destroyed by ants, but one of the dark specimens which I had given to Dr. Ingram remained. I was ordered off to Bida before I could get any more specimens, but on my return to Baro on September 24th, Dr. Ingram pointed out to me that the tsetse I had given him was almost absolutely black. It certainly was not black when I gave it to him. Some other specimens he and Dr. Morrison had collected a week before had similarly turned black, and it was at first supposed that the naphthaline used as a preservative was responsible for the remarkable change. But as all the specimens of *G. morsitans* taken had been treated alike, and only some half dozen had darkened, this could not be considered

proved. Finally, a specimen of Dr. Morrison's, which had not been exposed to naphthaline at all, was found to be black."

In all, 93 examples have been examined.

Comparative Table of the Morphological Characters of the Superior Claspers of G. morsitans *and* G. submorsitans.

	G. submorsitans.	*G. morsitans.*
Median lobes (*ml* in figs.).	With the outer (free) margins *straight* and *parallel*; sub-apical tubercle distinct, when extended.	With the outer margins *curved* and *converging* distally; apex with a median line or division; subapical tubercle absent.
Heel or posterior angle.	Usually strongly produced distally.	Usually broadly rounded.
Submedian prominence.	Relatively small, rarely extending beyond the heel; bristle inserted near the margin.	Very prominent and usually projecting considerably beyond the heel; bristle inserted considerably within the margin.
Inner lateral margin	Narrowly rounded distally; and considerable produced.	Broadly rounded distally; and not markedly produced.
Upper lateral group of bristles.	Relatively long.	Relatively short.

December 20th, 1910.

A NEW MOSQUITO FROM UGANDA.

By H. F. CARTER.

Assistant Entomologist to the Liverpool School of Tropical Medicine.

Culiciomyia (?) insignis sp. n.

Characters seen under pocket lens × 16.

Head black with pale scales; palpi black; proboscis black. Thorax and scutellum purplish brown. Abdomen black, with curved apical bands on the second, third, fourth and fifth segments and with lateral apical spots on the fifth, sixth and seventh segments. Legs black, unbanded.

Microscopical characters.

Head black, with white flat scales laterally and creamy white, narrow curved scales in the centre and extending towards the nape; many upright forked scales are also present over the whole surface, the lateral posterior ones being somewhat narrower and black, the rest being broader and with pale apices; a few dark bristles project between the eyes. Clypeus deep brown, almost black. Palpi and proboscis black. Antennae pale brown. *Thorax* uniformly purplish brown, clothed with narrow curved scales of a rather lighter colour: on the anterior margins are several white, curved scales; in the centre is a dark line running almost to the scutellum; on either side of this line and about half way between it and the margins is a single row of bristles; there are also some rather stronger bristles irregularly arranged along the margins, but more numerous over the wing-roots. Scutellum with similar colouring to that of the thorax, the mid lobe with six bristles and the lateral lobes with four. Metanotum dark brown. Halteres with pale stems, thickly covered with pale scales, the apices with small dark flat scales. *Abdomen*—first segment black, bare, except for two small median patches of dark flat scales and a number of golden bristles, most of the latter arising more or less in the centre and spreading out laterally; second and third segments with black scales and very marked apical curved white bands not quite reaching to the lateral margins; fourth segment similar, but the band just reaching the edges; fifth also similar but having in addition small apical lateral spots: sixth and seventh with apical, lateral, spots only; last segment black; venter mostly pale scaled. *Legs* almost black, unbanded: femora pale ventrally. *Wings* with the veins clothed with brownish scales; the median ones on the subcosta and first longitudinal vein being very broad, those on the other veins as in *Culex*; the lateral scales on all the veins short with blunt apices, somewhat resembling those of

Fig 1
Culiciomyia insignis Carter
Abdomen of female.

Taeniorhynchus, but smaller; fork cells of moderate size, the first posterior cell longer but not narrower than the second submarginal, its stem half the length of the cell; stem of second submarginal two-thirds the length of the cell; the anterior cross vein slopes towards the apex of the wing; the mid cross vein situated about twice its own length from the posterior cross vein.

Fig. 2.

Culiciomyia insignis. Carter.

a. Cross veins
b. Scales on 3rd longitudinal vein
c. Scales on subcostal vein.
d. Scales on first longitudinal vein.

Length 4 mm.

Uganda: Entebbe, 5. vi. 1910. (*Dr. C. A. Wiggins*). *Type* ♀ in the British Museum.

Described from a single female, the head of which is unfortunately denuded round the eyes; it is therefore somewhat difficult to determine its true generic position, but owing to the characters of the wing scales and its general appearance, it agrees best with the genus *Culiciomyia*. The species itself is easily recognised by the marked abdominal ornamentation and the dark unbanded legs.

24th November, 1910.

THE DISTRIBUTION OF TSETSE-FLIES IN THE PROVINCE OF MOZAMBIQUE, EAST AFRICA.

By C. W. HOWARD, B.A., F.E.S.

Chief of Entomological Section, Department of Agriculture, Mozambique Province.

(Map).

The presence of trypanosomiasis in cattle in the Province of Mozambique has made the question of tsetse-flies one of considerable interest and importance. During the past two-and-a-half years the writer has lost no opportunity of gathering information as to the whereabouts of tsetse-belts. It has been very difficult, because of the inaccessibility of most parts of the Province. The northern districts of Nyasa and Mozambique, for example, are practically impenetrable except for a few miles along the coast: no roads exist, and the natives, while not actively hostile, do not favour the intrusion of the white man. The northern part of the Zambesia district and the Tete district are likewise seldom visited by white men. It was not possible to organise a system of collecting reports of fly-belts from officials because of the small number of officials in these out-of-the-way regions. The writer has, however, been enabled to visit practically all accessible parts of the Province, and by questioning officials and natives and those who have been through the more inaccessible regions, has gathered considerable data. Specimens of fly have been secured from many of the places recorded. Although the few notes given are by no means complete, it seems best, however, to place them on record now.

Beginning at the north, I have two well-authenticated reports of tsetse from the Nyasa district. Toward the end of the dry season of 1908, during August and September, Major Hamilton, the game warden of the Eastern Transvaal, and the British Consul at Lourenço Marques, made a journey across this district, on foot. The road followed was from the seaport Ibo, southward to Port Amelia, thence westward along the Pulu river. Continuing westward about midway between the sea coast and Lake Nyasa, they passed through a strip of country between the Msalu and Lujenda rivers. The route then bent slightly south-west along the latter river, finally striking westward to Lake Nyasa near Fort Maguire.

A small quantity of fly was found along the Pulu river west of Port Amelia. It was along both sides of the river, and in very dense bush. But what was most surprising was the absence of game. Major Hamilton, who is a well-known hunter, informed me that he saw only one or two tracks of small game, no big game, and scarcely any feathered game. Between the Msalu and Lujenda rivers was a stretch of about 90 miles with thick bush and very little water. A large quantity of fly was found throughout the whole extent of this country. Here

again very little game was found. One water-buck was shot near the Msalu river, but after this not more than four or five tracks of game were seen, and only once was buffalo spoor found. A few elephants, however, were present in this region. After crossing the Lujenda river, game, including buffalo, became very plentiful, but no tsetse was to be found.

This statement must, of course, be taken with many allowances, for Major Hamilton, while a most careful and accurate observer, only followed a well-beaten native road across the country. At the same time, being such a careful observer and such a keen hunter, it seems probable that if game had been present he would have found it. It being the dry season, one would expect to find the game near the rivers. This, however, did not seem to be true. At the same time one would hardly expect to find tsetse in a region so dry as that between the Msalu and Lujenda rivers. All the game seems to have disappeared from the region east of the Lujenda river, and is apparently unable to migrate from the region to the west of it, as the river is very wide and deep, of a nature which game would not readily cross. Information which has been given me by Dr. Amaral Leal, of Lourenço Marques, would seem to throw some light on the conditions obtaining in one of these areas. Dr. Leal was stationed at Ibo some seven or eight years ago, and assures me that at that time the country immediately west of Ibo and Port Amelia was full of game. This fact would seem to indicate that in this area the fly has apparently survived the disappearance of game, and is able to exist without it. Although these observations cannot be taken as in any way proving that tsetse-fly is not dependent on the presence of game for its existence, it would seem to indicate that such might be the case. I believe that similar conditions have also been proved to exist in North Western Rhodesia, where, when game disappeared, the tsetse continued, often centering about the neighbouring kraals. A specimen of fly from each of the regions mentioned was brought back to me by Major Hamilton. Both are plainly *Glossina morsitans*.

Flies have been received from Port Amelia with the statement that they were collected from near that place; the exact locality was not, however, given. Austen, in his "Monograph of the Tsetse Flies," has a fly-belt marked on his map as existing along the Rovuma river, which separates this Province from German East Africa. As to whether this still exists I am unable to say, although I have had a report to that effect which is probably authentic.*

From the Mozambique district we have two records, one of a belt at Mapula near the south central part of the district, the second near the coast at a point north-west from the town of Mozambique.

The Zambesia district has some considerable fly-belts in the north-eastern area, and one report has been received recording the existence of fly in the north-western portion. There is fly in the parts of the Nyasaland Protectorate adjoining this district, and it is reasonable to suppose that it will also be found on the Portuguese side of the border. A specimen of *G. pallidipes* has been sent to me from Lekungo. Dr. Sant'Anna, of the Hospital service, has recently

[The existence of *G. morsitans* along the Rovuma has recently been fully confirmed by Mr. H. T. Barrett (see p. 43), and the fly-belts observed by him have therefore been added to Mr. Howard's map.—Ed.]

been through that portion of the district known as Maganja da Costa, and informs me that in nearly all parts of this region *G. morsitans* is to be found. I have examined his specimens, and find that he has both *G. morsitans* and *G. pallidipes* from Maganja. He also reports *G. brevipalpis*[a] from one locality in Maganja. Austen has belts located near Chinde, at the mouth of the Zambesi river, and also at the mouth of the Shiré river. These no longer exist. The coastal region is also quite free from fly. Cattle trypanosomiasis was present in herds at Mopea on the Zambesi in 1908–9, and also on the southern banks of the Zambesi to the westward, toward the Tete district, but a careful search in the adjoining regions failed to disclose any fly. The natives were quite ignorant of it. All the facts went to indicate that the disease had been introduced in cattle brought from Nyasaland and had then been spread through the herds by local biting flies such as *Stomoxys* or TABANIDÆ.

The Tete district, while not having as many fly-belts as one would be led to expect, has several well-known fly-areas in the central and northern parts. The western portion seems to be fairly free from fly. Drivers who have brought cattle across this portion, in the vicinity of Zumbo, from North Eastern Rhodesia into Southern Rhodesia, report that there is no fly until they arrive at the escarpment in Southern Rhodesia, some distance south of the Tete boundary, where the land suddenly rises to a higher level. Here in the kloofs fly is to be found.

Dr. Sant'Anna has also recently visited the Tete district, and kindly gave us his notes on the fly-belts which he found. A belt of *G. morsitans* exists on the road leading to the north from Tete to Villa Coutinho, near and north of the course of the Inyamandzi river, an affluent of the Revugwe river. A second belt was found near the Lingove river, another affluent of the Revugwe river. A third occurs about six hours south of Inyamandzi, while a fourth occurs two hours west of a place known as Muchina, in the same general region.

The district belonging to the Companhia de Moçambique has several fly-belts. In the northern part there is apparently a considerable amount of fly. While the south bank of the Zambesi river is itself quite clean, tsetse probably occurs at several places some distance inland. Trypanosomiasis has occurred among cattle along the river in the vicinity of Sena, but no fly is present at least within a considerable distance of the river, where the cattle graze. At Lacerdonia there is fly one hour's distance south from the river. About half-way between the Zambesi and Beira, toward the coast, is a place known as Chirugoma, in the vicinity of which are fly-belts of both *G. morsitans* and *G. brevipalpis*.

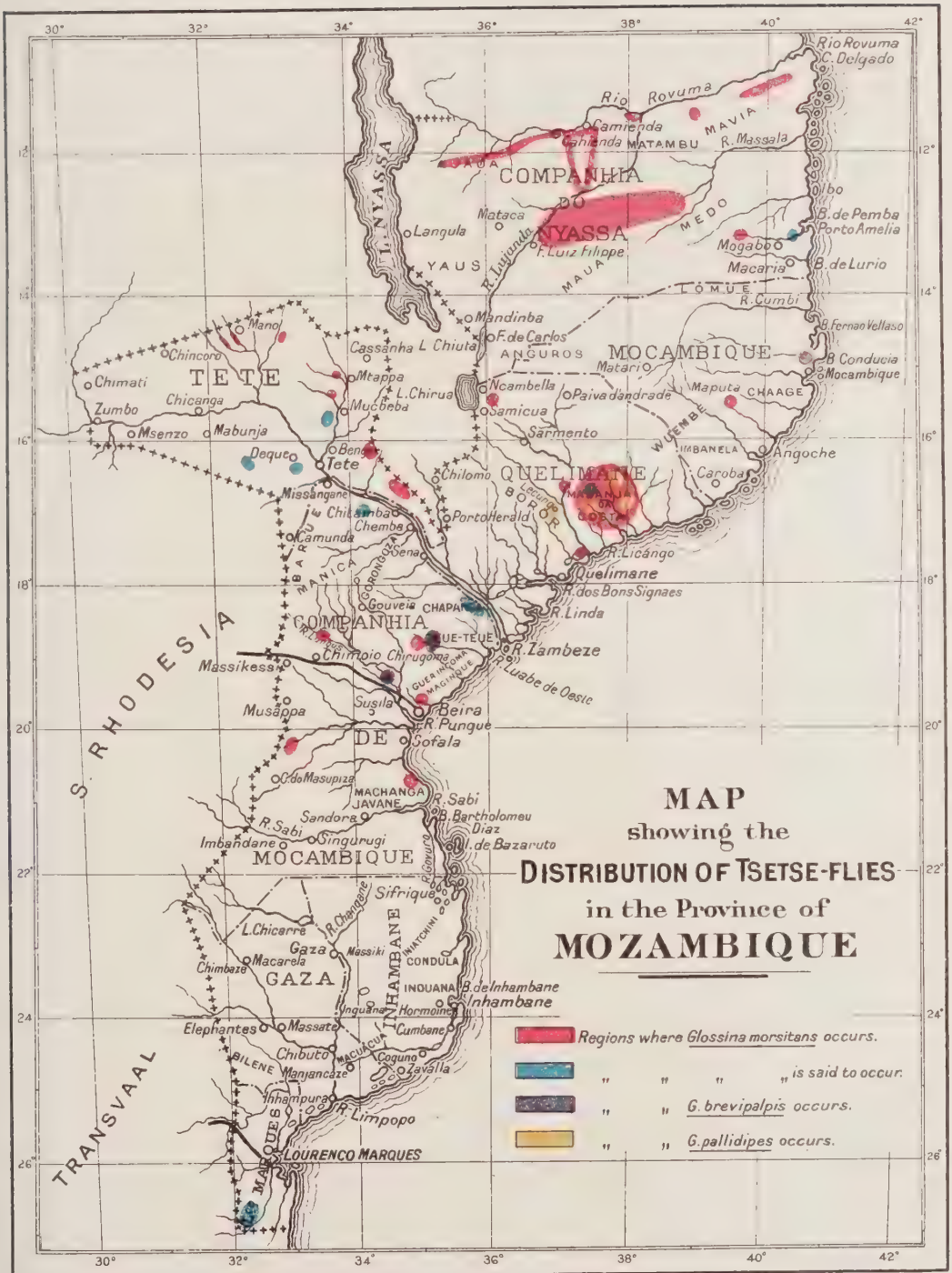
Twenty to twenty-five miles from Beira, near the railway line, is a belt of *morsitans*; another belt occurs about thirty miles south of Sofala; a third is known to occur near the Rhodesian boundary in the vicinity of Melsetter:

[a] [In his manuscript the author refers to this species under the name of *G. fusca*; but it is now recognised that the large East African *Glossina*, to which this name was formerly applied, is specifically distinct from the purely western *G. fusca*, and it has been described as *G. brevipalpis*, Newstead. In the British Museum there are specimens of this species taken at Bamboo Creek, on the Beira Railway, by Mr. L. E. W. Bevan, of Salisbury, Rhodesia; this record has been added to the author's map.—ED.]

while a fourth occurs near the Government farm at Chimoio. The southern and south-western parts of this district, as well as the northern part of Gazaland, are very little known and practically unentered by white men.

The southern part of the Province, including the Inyambane and Lourenço Marques districts, was at one time noted for the presence of tsetse. After the rinderpest passed over South Africa, however, the fly began to disappear, and we have been unable to locate a single tsetse-belt in this portion. In the southern corner of the Lourenço Marques district, toward the boundaries of Zululand and Swaziland, there is said to be tsetse. The reports are, however, all vague and indefinite, so that there is some doubt as to their reliability.

Lourenço Marques, 17th December, 1910.


MAP
showing the
DISTRIBUTION OF TSETSE-FLIES
in the Province of
MOZAMBIQUE
Regions where Glossina morsitans occurs.
" " " " is said to occur.
" " G. brevipalpis occurs.
" " G. pallidipes occurs.
COMPANHIA DO NYASSA
COMPANHIA DE MOCAMBIQUE
MOCAMBIQUE
TETE
QUELIMANE
GAZA
INHAMBANE
MANICA
S. RHODESIA
TRANSVAAL
Rio Rovuma
C. Delgado
Mataca
Langula
Mandinba
Mano
Chincoro
Chimati
Zumbo
Chicanga
Msenzo
Mabunja
Deque
Tete
Cassanha
L. Chiuta
Mtappa
L. Chirua
Mucoeba
Ncambella
Samicua
Sarmento
Paiva dandrade
Matari
Maputa
CHAAGE
Angoche
Caroba
Chilomo
Missangane
Chimbadzo
Chemba
Camunda
Porto Herald
Quelimane
R. dos Bons Signaes
R. Linda
R. Zambeze
Gouveia
CHAPANGA
Massikessi
Chimoio
Chirugoma
Musappa
Susila
Beira
R. Pungue
Sofala
C. do Masupiza
MACHANGA
JAVANE
R. Sabi
Sandora
Singurugi
Imbandane
Sifrique
L. Chicarre
Gaza
Macarela
Chimbaze
Massiki
CONDULA
INQUANA
Hormoine
Cumbane
Elephantes
Massate
Chibuto
Coguno
Zavalla
Manjancaze
Inhampura
R. Limpopo
LOURENCO MARQUES
R. Licungo
R. Lugenda
R. Luiz filhope
R. Luisanda
R. Massala
R. Combi
R. Lurio
B. de Pemba
Porto Amelia
B. de Lurio
B. fernao Vellaso
B. Conducia
Mocambique
B. de Inhambane
Inhambane
Lacerdonia
Luabe de Oeste
Rio Rovuma
Camienda
Cahienda
MATAMBU
MAVIA
MEDO
YAUS
MAUA
TOMUE
ANGUROS
IMBANELA
WUEMBE
BORORO
MASANJA OU LOESTA
GUERINGUE
MAGINQUE
MACUACUA
INHATCHINI
BARUE
CORONGOSA
Bartholomeu Diaz
I. de Bazaruto
R. Sabi
R. Changane
R. Govuro
R. Inhambane
R. Buzi
R. Pungue
R. Zambeze
R. Sabi
R. Licungo
R. Lugenda
R. Rovuma
R. Luisanda
R. Luiz filhope
R. Combi
R. Lurio
R. Limpopo
R. Inhambane
R. Buzi
R. Pungue
R. Zambeze

DIARY NOTES ON THE TSETSE-FLIES OBSERVED DURING A JOURNEY DOWN THE ROVUMA RIVER, PORTUGUESE EAST AFRICA.

By H. T. BARRETT.

Nyasaland Government Service.

(Map).

August 17th, 1910. Between Lupitanguo Pool and Namiwawa (1).* Bright day ; steady easterly breeze ; fly scarce, though present throughout journey : more plentiful by pools in shade. Country thickly wooded. Water plentiful. Buffalo country.

August 18th. Between Namiwawa and Mawola streams (2). Fly scarce, apparently none near camp by Mawola stream. Old spoor of elephant and buffalo. Bright day ; steady easterly breeze. Thickly wooded country.

August 19th. Caught six specimens in bush and trees fringing pools between Mawola stream and camping ground (3). Fine day, with occasional clouds. Fly numerous and bit incessantly. Buffalo and sable antelope country. Very thickly afforested with thin-trunked trees. Fly seem to come round the camp in cycles—that is to say, they swarm around for a time (10 minutes or so) and then for a time there are none to be seen.

August 20th. Fly scarce though existent throughout.

August 21st. Several specimens caught around the camp in vicinity of Lihuruhu stream, among trees and in dry river bed (4 & 5). Thick tree country. Game very scarce (only oribi seen) ; fly pestilential in numbers.

August 22nd. The three flies collected were caught among the trees around the camp by pool (6). Bright day. Waterbuck and kudu present. No traces of buffalo, though lots of old elephant spoor. Fly numerous.

August 23rd. Flies caught at camp on bank of Mtambiri stream (7). Dull morning and flies scarce though present. Abundant when sun shone at camp ; scarce near the water.

August 24th. On banks of Walezi close to junction of Lushilingo with Rovuma (8). Elephant and buffalo country. Flies numerous.

August 25th. Between Likaronga Hill and Rovuma (9). Tree country giving place to open plains. Flies fairly numerous. Sable, waterbuck, buffalo and elephant country. Day fine.

August 26th. In vicinity of Rovuma-Lushilinga confluence (10). One specimen caught on bank of Lushilinga. Dull day. Flies present in grass country with thin scattering of small thornless and almost leafless trees, but few seen.

* Such numbers in the text refer to similar numbers on the map, indicating approximately the localities in which tsetse-flies were actually caught.

August 27th. On Rovuma banks (11). Flies fairly plentiful in open country, with short grass interspersed with palms and stumpy trees, generally leafless. They were found in mid-stream where water was ¼ mile wide, but may have accompanied us from banks. They also appear to like reeds. Few are seen when weather is dull.

August 29th. Lisanyando stream (12). Flies plentiful in river bed and on the stones in the pools.

August 30th. One fly caught in tent and blood slide taken from it (13). Day fine; country moderately thick. Game plentiful—mostly waterbuck.

August 30th. Between Lisanyando and Rovuma falls (14). Day fine. Fly numerous. Medium country: the grass burnt in parts. Fly began to feed as soon as sun was up.

August 31st. Caught some flies in villages near the river (15). Ordinary bush country.

September 2nd. On bank of Rovuma (16). Flies caught at camp, in deep shade.

September 3rd. Caught some flies in village gardens at the camp, 300 yards from river and 50 yards from bank of small stream (17). Bright day. Fairly thick country around. Fly plentiful; seem to bite most about 4 p.m., providing weather is fine.

September 5th. Caught no fly, though they are present in vicinity of camp (on Chipindimbi stream) in limited numbers. Eland country; no buffalo.

September 6th and 7th. Flies were caught between Chipindimbi stream and Matondowera Hills (18). Sable and eland present in limited numbers, no buffalo. A specimen was caught in camp at 6.30 p.m., on the bank of Chualezi stream (near Matondowera Hills), forty-five minutes after sundown—quite dark. No game at, or anywhere near, camp (in village).

September 8th. Between Matondowera Hills and camp in marsh (19). Fly plentiful; they bite in this locality after sundown.

September 9th. Fly caught in bed of Mtapiri (20). They were plentiful throughout the trek.

September 10th to 12th. Flies were taken along Lujenda river near the Mtapiri confluence (21): and again at camp of 12th September, on bank of Lujenda, 8 miles N.E. of Mtapiri. Buffalo and elephant present. Fly fairly plentiful. Dense country.

September 13th. Near Lujenda river (22). Fly still present.

September 14th. Likwamba stream. Saw no fly, though probably existent: but weather very dull. Elephant and sable country.

September 15th to 18th. Fly in quantities among trees and in marshes. Vicious biters, though unobtrusive, and fill themselves with blood before being noticed. Feed by day and night. One specimen caught at 8.30 p.m. on 18th September: one other killed at midnight on 17th. Camp on marshy ground, fairly clear of trees (23). Nocturnal habits of flies may be accounted for by fullness of moon.

September 20th. Fly existent all the way (24). The fly here are different from those met with on the first part of the trek, as here they crawl inside the clothes.

September —. Easterwood's camp by Rovuma river. Flies crawl up trouser legs to the knee. Country is fairly thickly covered with trees, but they are leafless at this time of the year. No buffalo, but nswale (impala), waterbuck and kudu plentiful. Fly very numerous; one caught in grass hut.

October 14th. Eight miles east of Chualezi confluence (26). Dull day. Fly caught in open native hut, thick bush all round; Rovuma 100 yards away. Fly plentiful when sun shining, scarce when dull. Game (waterbuck) plentiful.

October 17th. Fly not seen: they stopped as soon as traces of waterbuck disappeared. Country different—broken and stony, with thick shrubby undergrowth, at present absolutely leafless and charred by fire. Day bright, with steady breeze.

October 18th. Hilly country close to the Rovuma, which clings to the hills and flows in a deep rocky hollow. Elephant, eland, zebra, kudu and sable country; no waterbuck and no fly.

October 19th. No fly till we arrived near the river, when one specimen seen at the same time as were some waterbuck. Other game teems.

October 20th. One fly seen. Eland and other game present. The fly was found by the river—none were seen away from it, though conditions favoured them. Perfect day. Country same as on the 18th October—thickly covered with short leafless trees, sandy, and dry leaves under foot.

October 21st. One fly seen in the bwalo* of a big village on the Lusanjesi, 15 miles from camp of the 20th October.

October 22nd. No fly seen.

October 23rd. One fly seen in high lying land near the Lujenda-Rovuma confluence.

October 26th. No tsetse seen since Lujenda crossed. Country similar to that previously met with in which fly swarmed, except perhaps that the bush is more dense. Leafless undergrowth is the prevailing feature.

October 28th. Saw one tsetse fly. Day sunny. Dense river undergrowth—palms and green shrubs.

October 29th. One fly caught in upland tree country: trees mostly leafless. Oribi and elephant the only inhabitants; no water within about 10 miles. A few other flies seen, though very scarce. Day very hot; in afternoon some clouds.

October 30th to November 1st. No fly seen.

Since the 2nd November no fly caught and no record kept. On one or two occasions however single specimens were seen near the river, in thick green country. Sun very hot in day time. Buffalo generally present inland from the river, to which they came down during the night to drink. The last of such specimens was seen at Palma on the coast.

Fly were first seen at Chisindo,—30 miles east of Lake Nyasa, and last, on the East Coast near the Rovuma mouth. There appeared to be few, if any, spots throughout the entire journey which fly did not inhabit.

* The cleared space in a native village where the chief hears cases and where the villagers congregate.

The statement so often made that sun is the chief enemy of the tsetse appears to be unfounded, at least as regards the species met with. On dull days the fly were remarkably scarce ; on the other hand in dry country with practically no shade, fly were most troublesome during the hottest hours of the day in blazing sunshine. When fly were not attacking they generally appeared to rest either on the ground or very near to it.

The fly met with in the Chualezi valley appear to be of a different species to those met with elsewhere. They are smaller, and their habit of nocturnal feeding is peculiar, as is also that of crawling considerable distances inside the clothing.

[The collection of 65 tsetse-flies brought home by Mr. Barrett comprises only a single species, namely, *Glossina morsitans*. The interesting differences in habits which were noted are not correlated with any colour or structural distinctions. It has long been known that *G. morsitans* will bite on moonlight nights, and occasionally even when there is no moon. The habit of crawling inside clothing does not appear to have been recorded previously in the case of this species, though well-known in *G. palpalis*.

The suggestion that *G. morsitans* specially associates with waterbuck requires confirmation, for the evidence cannot be regarded as sufficiently conclusive.

The country traversed by the author is hardly known at all to Europeans, and his notes and specimens have therefore a special interest. It is not often that travellers with no knowledge of entomology will take the trouble to make exact observations of this kind.—Ed.]

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THE PAPATACI FLIES (PHLEBOTOMUS) OF THE MALTESE ISLANDS.

By R. NEWSTEAD, M.Sc., A.L.S., &c.

(Plates I.—III.)

(*A report of the twenty-third Expedition of the Liverpool School of Tropical Medicine.*)

Acting under the instructions of the Liverpool School of Tropical Medicine I proceeded to Malta on the 25th of June 1910, and stayed in the Island for a period of two months. The object of this expedition was to investigate the problems connected with the menace to health caused by the blood-sucking "Papataci Flies" of the genus *Phlebotomus*.* The greater part of my time was devoted to searching for the breeding-places of these insects with a view to devising practical prophylactic measures for the control of the pest. Other phases relating chiefly to the bionomics of *Phlebotomus* were also investigated; and attempts were made to rear the insect from the egg.

On making a critical examination of the material collected during the first week of my visit, two distinct species (*P. papatasii* Scop., and *P. perniciosus*, sp. n.) were found to be almost equally abundant: and examples of a third, though apparently rare, species (*P. minutus*, Rond.) were subsequently taken. Since my return to England, Captain P. J. Marett, R.A.M.C., has very generously placed the whole of his collection of Maltese Papataci flies in my hands for examination and report: and among the numerous examples there were two specimens which have proved to be a new and hitherto undescribed species (*P. nigerrimus*, sp. n.), so that altogether four distinct species of *Phlebotomus* are now known to occur in the Maltese Islands.

These discoveries, though of much interest for the zoologist, add considerably to the labours of those who are or may be engaged in studying these insects more especially from a medical point of view: as owing to the minute morphological differences which exist between the females of these small midges the task of separating the respective species, more especially the commoner ones, is one which can be accomplished only after long and careful microscopical examination and comparison.

Hitherto the only species recorded from Malta was the common and widely distributed *P. papatasii*; but judging from recent experience, I have come to the conclusion that the almost equally abundant *P. perniciosus* must have been seen, though not recognised, by those who have been engaged in studying the bionomics of these insects.

It is highly probable too, that examples of this species were also used by those who conducted the transmission experiments, and although one has no direct proof, it is possible that *P. perniciosus*, like its near relative (*P. papatasii*), may also act as a carrier of Papataci fever.

* These insects are generally known to Englishmen as "Sand Flies."

The Search for Breeding-Places of Phlebotomus.

The results of my unremitting search for the breeding-places of these insects were that I secured two larvae from the crevices of the loose rock in the "caves" or catacombs at Notabile near the centre of Malta; thereby confirming the discoveries made by Captain Marett (6)* a month or so previously. Had my searches been continued in the same kind of habitat I have reason to believe that a few more larvae would have been secured, but having trained the eye so as to facilitate the finding of so minute an object the more readily on any future occasion, I proceeded in other directions, and searched innumerable places that were thought likely to form suitable breeding-grounds for these insects, unfortunately without discovering either eggs, larvae or pupae; disappointment met me at every turn and I am therefore unable to add anything that is new or noteworthy regarding the breeding-places of *Phlebotomus papatasii* or any of the allied species.

In addition to the cave from which larvae were secured I also inspected the places in which both larvae and pupae had been found by Captain Marett; these were the cave at Gozo, the embankment forming part of the Cottonera Lines, and the stone wall in Captain Marett's garden, which he had thoroughly explored and had also kept under close and constant observation for a considerable time. In all of these places the conditions were very similar, if not almost identical.

In the caves the larvae occurred in the crevices and fissures beneath the loose rock amongst the damp earth, &c., at some distance from the surface, and I was informed that those which were found in the stone wall, occurred low down near the foundations, well within the centre, and attached chiefly to the under surface of the stones: while those from the Cottonera embankment were found at some considerable distance from the surface, where the stones were damp (6).

The crevices between the loose rock in the caves were often found partly filled with soil rich in organic remains. In the caves at Notabile, in which the larvae were found, the soil had for the most part been reconstituted by the burrowing larvae of various insects and other allied animals. To such an extent had this been done in some instances that quite 50 per cent. of the deposit consisted of the rejectamenta of insects, woodlice (*Oniscus* sp.), &c. Here and there were found also large numbers of the empty pupae of *Stomoxys calcitrans* and the pupae of other Muscid flies whose larvae had matured in the stable refuse which had been stored in the cave for agricultural purposes.

In all of these places the conditions were practically the same, the three main factors being: (*a*) the presence of organic matter: (*b*) moisture, but not in excess; and (*c*) the absence of light.

The principal places which were searched as being likely to afford suitable breeding-grounds for Papataci flies were as follows:—The main sewers and the ventilating shafts in various parts of the city of Valetta: drains of various kinds, cesspools and latrines in many places: cellars and prison cells in the Police Court: sewage works, and the dark damp buildings used by the Customs as

* Such numbers refer to the bibliography on p. 77.

bonded stores: refuse of all kinds, especially such as occurred in dark damp places: the refuse "tips," and the roots of plants along the coast, especially in localities which were known to be badly infested with the flies: the decayed stems of the Prickly Pear (*Opuntia* sp.): collections of stone and rock in shady places in gardens and elsewhere: freshly excavated earth and rock: the empty shells of molluscs (chiefly *Helix* sp.) found in caves and other sheltered situations: refuse in caves which were used as stables for oxen and other domesticated animals, and the faecal matter which was found in those which had been used as latrines; the roots of trees, ivy and flowering plants which were kept moistened by constant supplies of water: the accumulations of leaves in damp places, &c.: litter from rabbit-hutches, consisting chiefly of faecal matter, especially at Casa Leoni, where the adult flies were invariably found associated with these animals.

Although one failed to discover either larvae or pupae in any of these situations, it does not prove conclusively, in my opinion, that these insects do not breed in some of them, especially as Grassi (3) has found that in Italy the larvae of *P. papatasii* live in dark damp spots amidst all kinds of refuse in underground places such as cellars, and particularly on the sides of drains which are kept moist by occasional splashes of dirty water.

Other investigators in Malta have met with results similar to my own. Lieut.-Colonel C. Birt, R.A.M.C. (2), who collected the most varied materials, states that he did not succeed in detecting the ova or larvae in any of the samples, "nor has the adult *P. papatasii* ever hatched out from larvae which might have been hidden in the materials." Captain Marett (6) has also made extensive search for the larvae and pupae in similar places and in similar materials, and has failed to find a single example of the insect in any of its stages. In so far therefore as our present knowledge is concerned, the only conclusion which can be drawn from the investigations in Malta is that the chief breeding-places of the Papataci flies (*P. papatasii* and *P. perniciosus*) are the crevices between the loose rocks in caves, stone walls, bastions and similar situations.

The task of finding such minute objects as either the larvae or pupae of these flies is, however, very great: of the two, the larvae are perhaps the more conspicuous, but these have the remarkable habit of flicking themselves from off the surface of the stone or other objects when exposed to light, and in this way numbers may escape detection even under the most practised eye. The pupae are the more difficult to detect, as, apart from their minute size, the colour so exactly harmonises with the colour of the rock to which they are attached that they are rendered almost invisible, and when detected appear only as a naturally formed granular projection on the surface of the stone. In every sense, therefore, they are highly protective forms, and numbers must necessarily escape detection, more especially when artificial light has to be employed in searching for them. Bearing these facts in mind, large quantities of detritus were collected from many and varied sources so that it could be examined under more favourable conditions, but in no single instance were these insects found in either of their preliminary stages, though a lens of low magnification was almost invariably employed in searching for them. Quantities of the detritus were also kept in large vessels in the hope that adult flies might be successfully reared from it: in this again complete

failure was the result. As to the detection of the ova in a state of nature I believe this to be a practical impossibility, as when laid upon dark substances they become absolutely invisible and can be detected only by the aid of a microscope. Even when laid in captivity in confined areas they are most difficult to detect, and under the most favourable conditions can be seen only when laid upon colourless or transparent surfaces such as white paper or the surface of a glass tube.

Habits and occurrence of the Adult Flies.

Though so evasive in their early stages, the adult flies may be found almost everywhere throughout the Island in favourable situations or localities. They outnumber the mosquitos, and the females may be included among the most vicious of all the blood-sucking Arthropods. They are distinctly "domestic" in their habits and may be considered among the most detestable of all man's "uninvited guests." It is a curious fact, however, that they have their likes and dislikes both in regard to hosts and habitats. I can fortunately place myself among the small numbers of those who have proved immune to the bites of these blood-sucking pests: or at least I have never consciously experienced the effect of their bites, any more than I have in the case of *Pulex irritans*. And this is all the more extraordinary because fresh comers to the Island, especially children, generally suffer torture from the bites of these insects, and many cases are admitted to the hospitals through the infection which the Papataci flies are known to convey. To say the least, they are an intolerable nuisance in every part of the world in which they are known to occur. Man is evidently, not the only vertebrate which these insects attack, as examples were frequently found which had filled themselves to repletion with the blood of the domesticated rabbit: so that it is evident that they are not entirely dependent upon man for food and the probabilities are that they subsist and flourish on any of the warm-blooded animals when man is not available.

My experience with regard to the favoured haunts of these flies is almost precisely the same as that of other investigators. In certain parts of the island they were found to be abundant, while in others, for some unaccountable reason, they occurred very sparingly, though the conditions necessary for breeding purposes, especially stone walls, abounded everywhere. In badly infested regions, too, they favoured certain dwellings much more than others; of two houses occupying the same aspect and surroundings, or a section of the same block or street, one was often found to be infested while the other was rarely visited. It was noted also that there was a marked domiciliary distribution in many houses. Bedrooms on the first floor, especially those occupying a position on the lee or sheltered side of the house, were particularly favoured, while those on the opposite side of the building were rarely visited; and rooms at a greater elevation (second floor), which I had under close observation for a considerable time, were only once found to contain a single example.

The naval and military camps at Ghain-Tuffeiha afforded also a remarkable instance of the local distribution of these flies, the naval camp on one side of the plain being badly infested, while the other and more extensive camp was said to be practically free from the invasion of *Phlebotomus*. This

remarkable localisation was in all probability due to the fact that the naval camp was bounded on one side by rocky ground and stone walls, affording excellent breeding-grounds for the flies, while the military camp was remote from such surroundings, and lying fully exposed in the open plain.

At times also, when Papataci flies were literally swarming in houses near the old bastion at Floriana, not a single individual was discoverable in the city of Valetta, half-a-mile away. In this instance also one may safely infer that the flies at Floriana were breeding in close proximity, and it is highly probable that the actual site was in the interstices between the masonry forming the old fortifications, only a few yards distant from the dwellings.

The daylight retreats of these flies were often similar to those in which they were found at night, providing always that there was an absence of direct light. Thus in the dwelling-houses and barracks, the flies were found at rest in the dark corners of the rooms, under garments, behind pictures and in other similar places; but in nearly all cases they occurred in considerably smaller numbers than at night, though there were one or two noted exceptions. In one instance they could be found in considerable numbers in a badly lighted bedroom at any time of the day, especially after a still, damp night with a heavy sirocco. Odd examples were also found in cellars and in the prison cells in the heart of Valetta; while numbers could be found almost at any time in the small caves or isolated catacombs at Notabile, and such retreats seemed to be one of their favourite haunts during the day. In the early mornings, shortly after daylight, examples of both sexes may frequently be found inside the mosquito curtains, and after favourable nights they sometimes get entrapped in large numbers by this means. On the slightest disturbance the males may readily effect their escape through the meshes of the net; but the females, which are generally engorged with blood, are, under such conditions, much more sluggish than at other times and may then be captured with comparative ease, as they cannot escape through the net very readily when the body is distended with food. In one or two instances Papataci flies were dislodged from the interior of stone walls by forcing tobacco smoke into the interstices; but one met with such little success that this method was abandoned. Sections of the lower portions of stone walls were also covered with chiffon and carefully examined at intervals during the night, and although the most favourable structures were selected for the purpose, and areas 36 square feet in extent were most carefully covered, not a single fly was entrapped by this method. This is all the more strange seeing that Captain Marett has met with marked success by adopting the plan even on a smaller scale. However this may be, it is perfectly obvious that in the light of Captain Marett's experience stone walls, especially those from which the surface "pointing" has fallen away in patches, leaving free access to the interior, are the frequent, and possibly the principal, resorts of the parent flies.

Atmospheric conditions have undoubtedly a marked effect upon the flies. On still sirocco nights they take to wing freely and occur in dwellings in larger numbers under such conditions than at any other time. On the other hand, when fresh cool breezes are blowing, especially from the north-west, they are rarely seen: and it is the testimony of everyone who has studied their habits that

these insects remain in their hidden and sheltered retreats and rarely venture forth at such times. There is little wonder at this, as their frail bodies and delicate wings are ill-suited for flight under such conditions: moreover it is a habit common to many members of the same order: minute midges, in particular, are often seen to swarm on still warm evenings, and rarely if ever assemble in numbers under any other circumstances.

A general belief is held by the Maltese that certain kinds of trees and shrubs (fig and loquat especially) form the principal resorts of these insects, and many are also under the impression that they breed either in the foliage or branches or in the fallen and dead leaves which lie beneath them. There may of course be a measure of truth in these theories: but we may at once dismiss the statement that they breed in the trees. It is perfectly obvious, however, that the presence of ornamental shrubs and fruit trees in the walled-in gardens would afford them just the kind of shelter and shade which they require, and would enable them in all probability to travel the more safely from their breeding-places to the house in the immediate vicinity. It is just possible that rotting vegetation in damp shady places, such as shrubberies, may form a breeding-place also, but so far as our researches have extended up to the present moment we have no evidence in support of this view. Considerable attention was paid to searching such materials but with negative results, as has already been stated. It is clearly evident moreover that dry materials, whether in a state of decay or otherwise, do not form a suitable breeding-place, especially dead leaves which may accumulate on the surface of the ground beneath the trees: light and dryness being both unsuitable conditions for the preliminary stages of the *Phlebotomus*.

The characteristic attitude of *Phlebotomus* is portrayed on Plates II and III. When at rest the wings slightly diverge and are elevated at a considerable angle above the thorax and abdomen. On the least disturbance the insects make short rapid flights, almost invariably to the right or left, reminding one of the rapid movements of a flea rather than those of a winged insect. Occasionally, however, they will take long-continued flights, when the course is more or less direct and distinctly midge-like. Their movements on the wing can be followed with little difficulty in daylight, but by artificial light it is almost impossible to do so for more than a few seconds at a time.

Both sexes live but a short time in captivity, unless they are fed upon human blood. Without this they will subsist on wet blotting-paper or other damp materials, such as soil, fresh leaves, &c. Under such conditions many examples survived for periods varying from three to nine days though the majority died on the third and fourth days, even although the females, in many instances, had taken a meal of blood a few hours before they were captured.

Seasonal Prevalence.

The adult insects were more or less prevalent during the whole of my stay in the island (July, August, and the first week in September). That the numbers fluctuated during this period has already been mentioned, but this was apparently due, in a large measure at least, to variations in temperature, humidity, and wind. Relatively few Papataci flies occur before the middle of June, and

practically all observers of their habits informed me that they occur most freely and are most troublesome during the hot, dry months of the year. It is highly probable that successive broods are produced during the summer months, but as the larval stage occupies apparently a long period, the successive generations can be produced only at extended intervals.

As to whether the larvæ occur most frequently during the summer remains to be seen. It is my impression, however, that they may be found more abundantly in autumn and winter than at any other season, and careful search should be made for them a week or so after the adults have disappeared.

Prophylactic Measures.

In consideration of the facts which have so far been brought to light regarding the economy of *Phlebotomus*, it is clearly evident that the task of suppressing these insects is an almost insurmountable one. Had we to deal with insects as large and as accessible as mosquitos, the adoption of prophylactic measures would be comparatively easy, but owing to the extremely minute size and almost flea-like habits of the adult insects, and the enormous area over which the breeding-places may occur, we are faced with a problem which is most difficult of solution.

As I was unable to devote any time to experimental work bearing upon the control of these pests, the only course open to me now is to suggest a few measures which may ameliorate the existing conditions and lead to a reduction of the malady of which these insects are transmitting agents. It seems to me, however, that the only practical way of grappling with this question is to proceed tentatively at first, and although I have discussed an extensive field of operations which may be directed against these insects, I would pin my faith rather to some of those measures which are considered under the following headings. But in the first instance it must be borne in mind that precautions against the bites of blood-sucking insects, though feasible to intelligent and well-to-do persons, are not as a rule employed by the mass of the people. Yet any prophylactic measures which are calculated to diminish the infection, even in a small degree, should be seriously and persistently employed.

Repellents.—I had no opportunity of demonstrating the value of these by experiment owing to my immunity from the bites of these insects, but I was assured that several good formulæ were in general use, though proprietary preparations were rarely employed. Judging by the testimony of those who had used such deterrents, one of the best was that which was prescribed by Major Crawford, R.A.M.C., and I am extremely indebted to him for giving me permission to embody it in this report. It is composed of the following ingredients :—

Ol. Anisi, 3 grs.
Ol. Eucalypti, 3 grs.
Ol. Terebenth, 3 grs.
Unq. Acid Borac.

Spraying with repellents.—The least objectionable of these, and at the same time one of the most effective, is formol or formaldehyde. The dark portions

and angles of sleeping apartments should be sprayed with a 1 per cent. solution of this substance every day during the season in which the flies are prevalent: a fine spraying apparatus is necessary for its application, and an excessive amount must not be applied. It is considered an excellent plan also to spray the mosquito curtains regularly every day towards sunset; nets thus treated are claimed to repel the attacks of these insects.

Fumigation.—There are several substances which are employed as fumigants for the destruction of insects, but I fail to see the practical utility of employing such means for the destruction of Papataci flies in Malta or elsewhere.

Light.—Daylight is a most important factor in driving away these insects from man's dwelling-places, and directly a flood of light is admitted to a room in which Papataci flies may be present, they immediately seek places of concealment behind garments or draperies and pictures, or other furniture which may be suspended from the walls or placed in dark corners. It is important, therefore, that as much light should be admitted into the rooms as is possible, and this can easily be done either in the early morning or evening, or when the windows are lying in shadow.

Beds should be arranged in the best-lighted portions of the room, and on no account should children's cots be placed in out-of-the-way corners in deep shadow. Decorative drapery in such apartments should be abolished, and the walls rendered as free from pictures and other furniture as possible.

Artificial light does not, unfortunately, act as a repellent; on the contrary, it would appear to serve as an attraction for these insects, as it is well known to do with other groups belonging to widely different orders.

Artificial air movement.—In India, if not also in other parts of the tropics, it is a recognised fact that punkahs and fans will repel the attacks of mosquitos if continuously and properly employed. It seems to me, therefore, that if a similar method could be applied in Malta, we should be able to dispense with almost every other form of prophylaxis which is discussed in this report. As it has been abundantly proved that Papataci flies do not take to wing when the slightest breezes are blowing, one may safely infer that they would not face a strong current of air such as would be produced by either fans or punkahs. It is unlikely that the latter will ever be employed in Malta, but it is my firm belief that if electric fans were fitted so as to produce a current of air in the direction of the window in sleeping apartments, that very few, if any, of the flies would be able to pass through the open window into the room beyond. I venture to recommend, therefore, that this method be put to the test, and if found to give satisfactory results, that it be employed in all cases where the cost of running such an apparatus is not a serious consideration.

Traps.—If a modified form of the biscuit-box trap, such as is used for capturing mosquitos, were fixed high up in the dark corners and angles of the rooms, I believe that numbers of Papataci flies would be entrapped. The trap should be made in the form of a corner-cupboard in miniature, and should measure about 18 inches in length; the basal portion should be left open, and the interior should be lined with dark cloth or similar material. These should be examined daily and the flies killed with ammonia fumes.

Nets.—The use of ordinary mosquito nets is of no avail against the bites of these pests, as they readily pass through the meshes, and attack persons just as freely as if nets were not used; but if they could be rendered repulsive to the insects by spraying them with formol or other repellents, as has been suggested, so much the better; but experiments in this direction must be conducted before we can say definitely that such a method would prove effectual. Fine nets made of strong chiffon or other similar material would undoubtedly prevent the approach of these flies, but the use of such nets would render sleeping almost impossible in the hot weather unless electric fans were used at the same time. If such preventive measures as these could be employed to the complete satisfaction and comfort of patients in hospitals, especially those suffering from the Papataci fever, or to the community in general, we shall have succeeded in devising an excellent prophylactic measure. If a net of this type is used, it should have a strip of calico about two-and-half feet in width stitched all round the bottom, so that at least 12 inches of it extends above the bedding, the remainder to be tucked in under the mattress. The use of this is obvious; the strip above the bedding would prevent the flies from biting any portion of the body which might be brought into contact with it, and the lower portion of it would stand the strain of "tucking-in," and consequently last for a very much longer time than such flimsy material as chiffon.

Destruction of breeding-grounds.—As to the operations necessary for reducing the number of breeding-places, it is perfectly obvious that we can never expect to be able to deal with these in any of the rural districts, owing to the fact that the fields and roads extending over the whole of the country are bounded by stone walls, and elsewhere there are fissured rocks, caves, and other suitable places which afford just the right conditions necessary for the breeding of Papataci flies. On the other hand, we may reasonably hope to reduce them in the principal centres of population, if persistent efforts are made to accomplish this, and the financial considerations do not prohibit the employment of such methods as are herein suggested. If it should be considered advisable to carry out any section of this part of the propaganda, one of the smallest and most isolated of the infested areas should be chosen as an experimental ground, and an officer who is thoroughly acquainted with the habits of the insects should be appointed to direct the operations. If loose rubble walls exist in the immediate neighbourhood of the selected area, these should be either demolished and the materials removed, or they should be completely covered with a thick layer of cement.

If such a type of wall exists as has the jointings partly filled with plaster ("pozzolani"), then all openings and fissures should be carefully filled in with cement, so that no holes are left for the ingress or egress of the flies, remembering always that a crevice sufficiently large to admit a flea will also afford ample space for the admission of the fly.

If it should be found necessary to replace the old walls with new ones, it is imperative that these should be built of solid masonry to a height of at least two feet above the level of the soil on either side, as it is the lower portions of the walls that are, according to Captain Marett's experience, selected as breeding-places; but it would be better, in my opinion, to make all new walls of solid

masonry from the foundation to the topmost course or layer : and if the old wall could be substituted by any other form of boundary, so much the better.

There are also other kinds of walls which may have to be dealt with, and these are they which form the old bastions and other extensive fortifications at Cottonera and elsewhere. In cases where such structures are backed with rubble and finally protected with loose rock, it would be a comparatively easy task to prevent the egress of the flies through such loose material by breaking or pulverising it, or by covering it with soil ; but unfortunately the question of pointing the Ashlar work forming the facings of the bastions and curtains presents not only a serious financial difficulty, but a task which could be accomplished only by a huge army of men ; and in consideration of these facts it seems to me that in the present stage of our inquiry such a method of procedure would be extremely unwise and irrational. For the time being, therefore, I should strongly advise that in selecting the experimental area a site should be chosen which is as remote from the old fortifications or similar structures as is possible.

Though there is no evidence which will lead us to believe that Papataci flies breed in the cellars and drains in Malta, at the same time we must not lose sight of the fact that Grassi (3), as has already been stated, has found larvae of *P. papatasii* in such places. It is highly probable, therefore, that this species breeds in similar habitats in Malta also ; but it is impossible without more study to make any definite statement on the point. Taking all the facts into consideration, therefore, I consider that the only really practical prophylactic measures which can at present be taken are those which are considered as precautionary against the bites of these insects. It is perfectly obvious moreover, that any operations which will not bring about an almost complete destruction of the breeding-grounds are not likely to make an appreciable reduction in the numbers of these insects.

Synonomy, Affinities and Morphology of the Genus Phlebotomus.

Though the differential characters of this genus have been given by several authors, and Grassi (3) has published an elaborate memoir on the morphology and biology of *Phlebotomus papatasii*, I consider that this report would be incomplete without giving some details concerning the morphology of these insects ; all the more so because Grassi's paper, in Italian, is now very difficult to obtain and also a very costly publication, in fact the price (£1 10*s.*) for so small a work, is practically prohibitive, and certainly not within the reach of students in general.

I do not claim, however, to treat of this phase of the subject in an exhaustive way, but rather to point out the salient characters of these insects in a measure that may be helpful both to the medical profession and to the zoologist.

The genus *Phlebotomus* was established by Rondani in 1840, though the species for which it was founded had been placed by various authorities in other genera, such as, *Bibio* (Scopoli, 1786), *Musca* (Gmelin, 1788-1793), *Ciniphes* (Costa, 1840). But as Rondani's name is now generally accepted, one need not go into

further details regarding the nomenclature and synonyms of *Phlebotomus*. The taxonomic position of this genus is with the family PSYCHODIDAE, and it is included in the sub-family PHLEBOTOMINAE. All the members of this family are small Nemocerous insects characterised by the possession of relatively large wings which are clothed with either scales or hairs; and one of the most familiar representatives, and one also which is widely distributed and nearly related to *Phlebotomus*, is the genus *Psychoda* (sub-family PSYCHODINAE) the members of which are known generally to Englishmen as "Moth-flies" or "Owl-midges." The short diagnosis which follows, will serve at once to distinguish *Phlebotomus* from any of the allied genera in the PHLEBOTOMINAE and also from the midges belonging to the PSYCHODINAE.

Genus PHLEBOTOMUS, Rondani.

Mouth formed for piercing and sucking; palpi of five segments: antennae long, filiform and composed normally of 16 segments; wings hairy, narrow, second longitudinal vein twice forked, cross-veins placed near the basal fourth of the wing; body clothed with hairs; sexual dimorphism distinct.

The larva (Pl. I., figs. 7-8) is characterised by its caterpillar-like form (eruciform); by the presence of two pairs of long caudal bristles, which may equal the length of the body; and by the absence of the true legs.

The pupa (Pl. I., fig. 12) is obtectate, and may be recognised by the presence of the larval skin which invariably remains attached to the last two segments of the abdomen. It should be borne in mind, however, that the partial retention of the larval skin by the pupa, is not peculiar to the genus *Phlebotomus*, as Speiser (8) has shown that the larval skin of *Helea* (*Forcipomyia*) *regulus*, Winn., one of the members of the CHIRONOMIDAE, also remains attached to the anal segments of the pupa. The larva of this genus does not, however, possess the long caudal bristles which are so characteristic of *Phlebotomus*, though in other ways it is not unlike the latter.

EXTERNAL MORPHOLOGY.

Head (figs. 1 and 9) somewhat elongated, but distinctly narrowed at the nape, vertex clothed with long hairs: clypeus large and also clothed with hairs on the upper surface. Eyes large and intensely black.

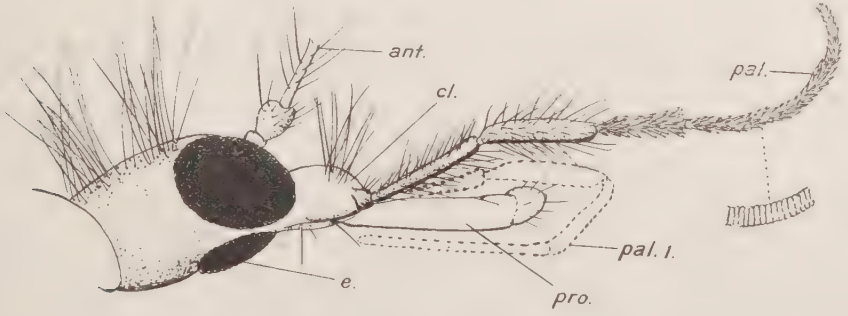

Fig. 1.—Head of *Phlebotomus papatasii*; *ant*, antenna; *e*, eye; *cl*, clypeus; *pal*, palpus; *pro*, proboscis.

Antennae (fig. 2) very long and slender, and in all of the Maltese species consisting of 16 segments: the first and second segments forming the scape are short and stout, the second one being somewhat spheroid in shape: the third is much the longest and of uniform width throughout: the remaining segments are gradually swollen proximally, especially the terminal ones; all are

Fig. 2—Antenna of *Phlebotomus papatasii*.

clothed with hairs: those arising from the swollen portions being much the longest and considerably longer than the individual segment to which they are attached. In all of the Maltese species there are also present on several of the segments, and in both sexes, *a pair of relatively large geniculated spines* (fig. 2). These curious appendages are rendered practically invisible when the segment to

which they are attached is mounted so that a dorso-ventral aspect is presented under the lens of the microscope: and for this reason apparently they have been hitherto overlooked by all the students of this genus of insects. It is true that Grassi (3, p. 12) has noted that "here and there one can observe a short hair curved and relatively thick": but that he failed to recognise the true character and arrangement of these spines is perfectly clear. Now that they have been discovered it is highly probable that they will be found to exist in the majority of species, if not in all, and may I think be considered of generic importance. Annandale in his description of the genus *Brunettia*, a new Psychodid discovered in Southern India, refers to a similar character, but in this instance the paired spines are somewhat S-shaped and relatively much stouter than the corresponding spines in *Phlebotomus*. In the light of these discoveries, therefore, it is possible that similar spines may be discovered in various other members of the same family, though it is highly improbable that such structures will eventually be found to exist in all of them.

Palpi (figs. 1 and 13).—These organs are generally said to be composed of four segments, but there are undoubtedly five, and this number may I think be considered common to all the members of this genus. Annandale (1) has pointed out that "a minute basal joint can sometimes be distinguished in fresh specimens" but that it is "often difficult to see and appears to be imperfectly separated from the others." That the small basal segment is clearly articulated to the second there can be no doubt, as it can be seen quite distinctly when mounted so that it is not obscured by the surrounding structures. All of the segments are clothed (in *P. papatasii* at least) with variously formed scales, intermixed with a few hairs. The scales on the first three segments are for the most part very long and somewhat hair-like, those on the remaining segments short and closely packed together. The fourth and fifth segments, especially the latter, are distinctly but somewhat irregularly annulated or ringed, a character which has also been hitherto overlooked by former investigators. In life, when these organs are at rest they are bent downwards and backwards at the articulation of the third and fourth segments, so that the anterior half of the palpus is folded back more or less upon the proximal half; by this curious arrangement practically the whole of the proboscis is covered or protected (fig. 1, *pal.* 1).

Proboscis (figs. 1 and 3).—Slightly shorter than the head, inclusive of the clypeus; in form it is somewhat cylindrical and slightly recurved distally. In the female it is composed of the following parts:—*The labium* (fig. 3, *lb*). This is much the largest organ, and as far as one can judge by viewing it in optical section, it almost completely embraces the labrum-epipharynx: the proximal half is sparsely clothed with lanceolate scales, and the first third is markedly narrower than the rest; immediately in front of the dark chitinous apodeme or sclerite is a curved row of long fine hairs; the labella are scarcely broader than the widest portion in the region of the apodeme, and are clothed with a number of fine and rather long hairs. *The labrum-epipharynx* (fig. 3, *lbr*) is relatively narrow and the sides are parallel, but the apex is suddenly attenuated, the tip bluntly pointed, and the margins furnished with a series of long spinose teeth set closely together and numbering about twenty on either side; ventrally it is

deeply and broadly channelled but does not appear to possess interlocking teeth or other structures. *The hypopharynx* (fig. 3, *hy*) is similar in width and general form to the labrum, but tapers off much more gradually towards the end and the marginal spinose teeth are much shorter and placed so closely together as to present a finely serrated edge: its upper surface is distinctly and broadly concave or trough-like and the salivary duct which is small, occupies a central

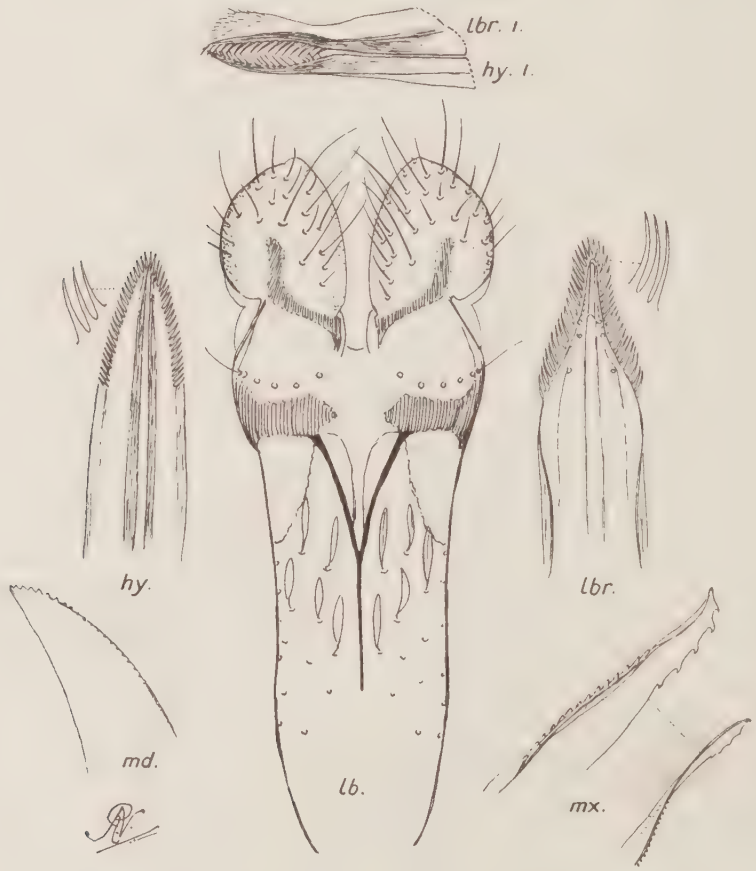

Fig. 3.—Mouth-parts of *Phlebotomus papatasii*, ♀ ; *lb*, labium ; *lbr*, labrum-epipharynx ; *hy*, hypopharynx ; *md*, mandible ; *mx*, maxilla. The uppermost figure represents the labrum and hypopharynx of the male, as seen in profile.

position. *The mandibles* (fig. 3, *md*) are broad and blade-like, and have the outer edges faintly serrated, the serrations being rather widely separated. When at rest they lie, apparently, superimposed one over the other. *The maxillae* (fig. 3, *mx*) are much narrower than the mandibles, curved transversely, and attached to a broad trough-shaped sclerite, not to a long slender stalk as Grassi has shown. One edge is provided with five relatively large and widely separated teeth; the opposite edge with smaller ones set closely together.

Thorax (fig. 8, p. 63). This consists largely of the meso-thoracic division, the prothorax being represented by a very short extension which can be seen more or less distinctly in examples which have been macerated and mounted in Canada balsam. The scutellum and post-scutellum are well developed and conspicuous in mounted preparations.

Abdomen.—This is composed of ten segments, the last being modified by the external genitalia. In the female the appendages are simple, flattened, leaf-like structures, densely clothed with hairs and arranged in two pairs (figs. 8 and 10). In the Maltese species they are all so similar in structure as to afford no diagnostic characters of importance. Annandale (1) states (p. 41) that these organs "become distorted and shrivelled in dried specimens." These structures can, however, be restored by maceration in caustic potash but the best results may be obtained by preserving the specimens in alcohol.

External genitalia of the males.—These are large and complex structures (figs. 14–18, pp. 70–74) and afford a ready means of determining the sexes; moreover, their morphological characters are of great importance as they present very marked specific differences whereby the closely allied species may be readily distinguished. These appendages are arranged in five pairs as follows:—*Superior claspers* (*sc* in all the figures). These are placed dorsally and are larger than any of the other structures; they are composed of two distinct segments, of which the terminal or distal one is the smaller and is provided at the apex with large spines, which in some species are curiously modified. They are generally densely hairy and large scales may also be present: but both hairs and scales are easily deciduous and the greater portion of them usually fall away during the process of mounting for microscopical study. The accompanying illustrations must therefore be considered as representing these structures in a partly denuded condition. *Inferior claspers* (*ic*). These are unisegmented and much shorter than the superior pair: they are ventrally placed and may or may not have modified spines at the distal extremity. *Submedian lamellae.* These lie between the inferior claspers, and although they are usually short, thin, leaf-like structures, in some instances (*P. minutus*) they are very similar to the clasper both in form and length. *Intermediate appendages* (*ia*). These occupy a median position and are often curiously modified: they form a branch of the superior clasper and are sometimes bi-lobed. *Intromittent organ* (*io*). This is homologous with the "juxta" in *Glossina*, and is described as the penis by Grassi. It consists of a pair of long slender and highly chitinised organs which lie between the intermediate appendages. These completely ensheath the two long filamentous processes which form a continuation of the ejaculatory duct leading from the penultimate segment of the abdomen. In *P. papatasii* they have not been seen to extend beyond the intromittent organ or penis, while in *P. perniciosus* (figs. 16, 17, p. 72), though lying apparently in a normal resting position, they project beyond it to a distance equalling one-half the length of the sheath.

Wing.—This is densely hairy, and may at once be distinguished from that of the mosquitos (CULICIDAE) by the entire absence of scales, the double fork of the second longitudinal vein, and the proximal position of the cross-veins.

The hairy character is well shown in the illustrations (Pl. II., fig. 2, and Pl. III., figs. 1, 2), and when denuded (figs. 4-7), the venation can be seen with little difficulty in properly prepared specimens. The costa is the thickest

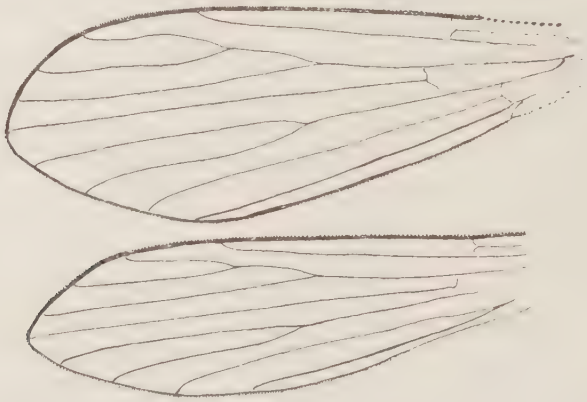

Fig. 4.—Wing-venation of *Phlebotomus papatasii*; upper, ♀; lower, ♂.

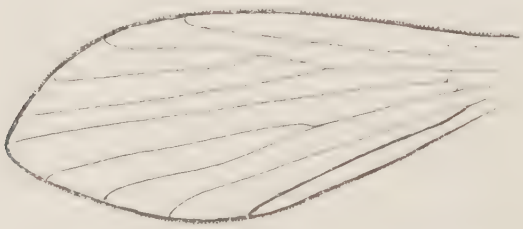

Fig. 5.—Wing-venation of *Phlebotomus nigerrimus*.

Fig. 6.—Wing-venation of *Phlebotomus perniciosus*.

Fig. 7.—Wing-venation of *Phlebotomus minutus*.

of the veins. The sub-costa, in comparison with that of the CULICIDAE, is very short, curves downward distally, and joins the first longitudinal vein at or about one-fourth of the distance between the base and tip of the wing. The first

longitudinal is simple, and unites with the costa about one-third from the tip: the second longitudinal is twice forked, and extends almost to the base of the wing; the third longitudinal is simple, and originates from the mid cross-vein; the fourth has origin at the base of the wing and is forked near the middle; the fifth and sixth are simple and united basally, the former curving upwards and uniting with the fourth considerably in advance of the base of the wing. The first cross-vein unites the costa with the sub-costa at a point immediately opposite to the turned-down portion of the latter, so that in effect they produce two cross-veins: the first extending from the first longitudinal vein to the sub-costa, the second from the tip of the latter to the costa. The mid cross-vein arises from the base of the third longitudinal and passes obliquely to the fourth; while the supernumerary vein is placed immediately above it, and passes obliquely to the second longitudinal.

Legs.—These are very long and slender and densely clothed with scales, the majority of which are flat and closely resemble those which are found in the CULICIDAE. The ungues are simple in all of the Maltese species, and do not offer any differential morphological characters.

INTERNAL MORPHOLOGY.

The Alimentary Canal (fig. 8).

This structure differs from that of the mosquito in having a true sucking stomach, and also in the possession of four Malpighian tubules instead of five. The general form and relative position of these organs in the female are as follows:—

The buccal cavity lies at the base of the clypeus; it is dilated distally, but almost immediately contracts and forms a slender tube which leads to the pharynx.

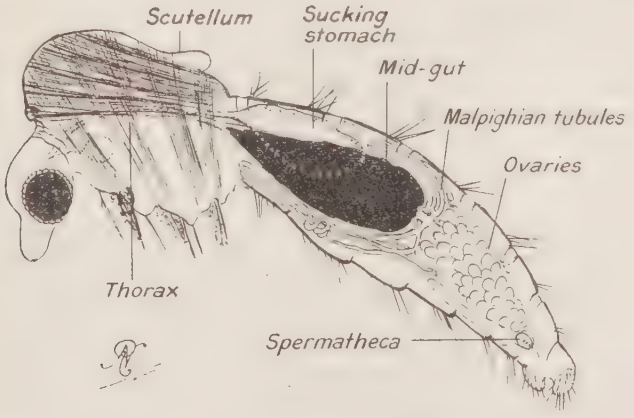

Fig. 8.—Internal morphology of *Phlebotomus*.

The œsophagus divides at a point a little in advance of the posterior margin of the head (nape), one tube leading to the sucking stomach, or food-reservoir, the other to the digestive canal.

The sucking stomach. This is a large, thin-walled pouch, connected with the end of the oesophagus by means of a very slender tube. It lies on the left side of the digestive canal, and extends distally as far as the region of the fourth abdominal segment.

The mid-gut or chyle stomach. This is capable of great distention, and when filled with fresh blood occupies a large portion of the abdominal cavity; but when such food has been partly comminuted it becomes much smaller, and can be easily seen as a black, elongated pouch in the anterior portion of the body.

Malpighian tubules. There are two pairs of urinary organs, each pair being united at their bases, where they form a single tube, which is connected with the intestine immediately below the mid-gut. They are of great length, extending forwards as far as the first abdominal segment, where they are folded and doubled backwards upon themselves, and also form loops in the mid-region of the ventral portion of the abdominal cavity.

The salivary glands (fig. 9). These consist of two broadly dilated or lobe-like acinous glands, lying one upon either side of the prothorax. The periphery of

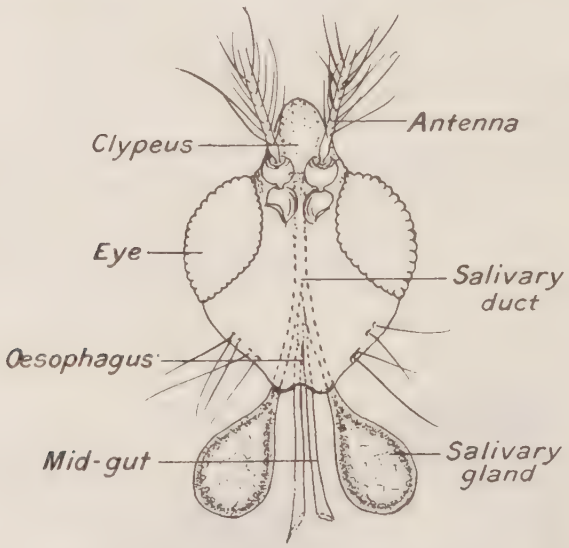

Fig. 9.—Head of *Phlebotomus*, showing position of salivary glands.

these glands presents an even or smooth surface, and immediately within the exterior wall is a series of rather large secretory cells. The ducts leading from the acini unite near the mid-region of the head, forming a common duct, which enters the buccal cavity close to the base of the clypeus.

The Sexual Organs of the Female.

The ovaries occupy a variable position in the different stages of their development. In the early adult stages of the insect (fig. 8) they are very small, and are seen to extend from just behind the origin of the Malpighian tubules to the region of the penultimate segment of the abdomen. When fully matured

(fig. 10) they occupy practically the whole of the abdominal cavity, extending forwards as far as the second segment. They are bi-lateral, and each ovary comprises 20–25 ova, representing a full complement of 40–50, so that these

Fig. 10.—A female *Phlebotomus*, showing fully matured ovaries.

insects cannot be considered very prolific. The tubular oviducts unite at a point just before reaching the base of the inferior claspers, where they form the common oviduct.

The spermathecae (fig. 11) lie in the median line in the region of the oviducts. They consist of a single thin-walled, sub-spherical sack, and are relatively very large ; at their junction with the duct they are strongly chitinised, and consist of

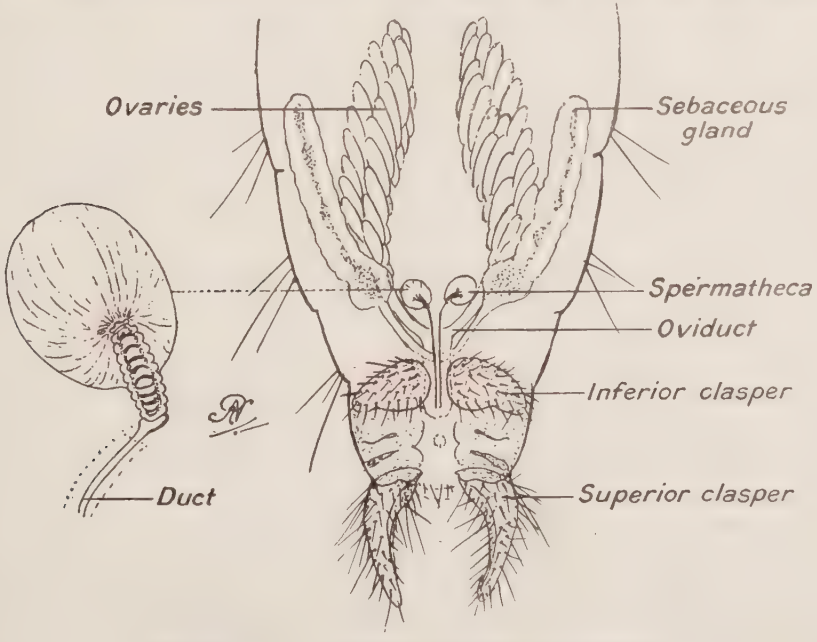

Fig. 11.—Female generative organs of *Phlebotomus*.

usually ten transverse and convex ridges, which are so constricted at the margins as to present, in optical section, a distinct and well-marked crenulation. The tubular ducts, which are long and straight, open into the oviduct near to its termination, apparently.

Sexual Organs of the Male (fig. 12).

The external characters of the male armature or copulatory apparatus have already been discussed (p. 61) and although the internal sexual organs have been

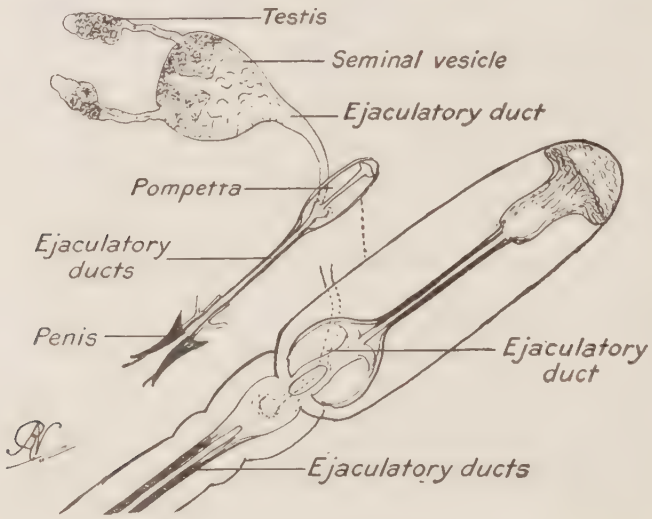

Fig. 12.—Male generative organs of *Phlebotomus*.

but briefly studied, from preparations examined in optical section, yet a brief account of them may not be without interest. These consist of the following :—

The testes. These may present a somewhat variable outline, though normally they are elongate-ovate : they are distinctly paired and widely separated, each possessing its own duct which enters the seminal vesicle at its anterior lateral margin.

The seminal vesicle consists of a large pyriform sac, the proximal portion of which gradually narrows and merges into the short, tubular, ejaculatory duct.

The ejaculatory duct is connected with a singular morphological structure which, together with the chitinous rods, presents a slender and somewhat club-shaped though cylindrical process. The outer wall of the swollen portion is formed of thin transparent chitin ; and occupying a central position is a piston-like rod which is dilated at both extremities ; the distal portion somewhat resembles an inverted bulb, the opposite dilatation forming a more or less spherical sac. The space between the central structures is seen to contain delicate muscular fibres ; and the ejaculatory duct leads into the spherical cavity at the lower end of the piston-like rod. Grassi's interpretation of the mechanism of this structure is that it acts like a little pump (*pompetta*) and regulates the exit of the spermatozoa. Beyond this structure the ejaculatory duct is protected

by two slender hair-like rods which are highly chitinised and form the "intromittent organ" which has already been described (p. 61) as extending into and in some cases considerably beyond the penis-sheath or juxta.

Oviposition of Phlebotomus in Captivity.

The act of oviposition was observed on several occasions and was not without interest, as the insect assumed a position which seemed altogether unique and extraordinary. In the first instance, a female with ripe ova was placed in a small glass-topped box, the bottom of which was within focal distance of a lens magnifying 8 diameters. She was supplied with blotting paper which had been soaked in clean water. On placing this in the box the insect immediately alighted upon it, brought her proboscis into contact with the paper, and after a few seconds appeared to be perfectly intoxicated and helpless. Unfortunately she struggled away and was finally hidden beneath the paper so that further observations at the time were impossible. After an interval of a few minutes she reappeared, crawled up the side of the box, and one and a half hours later seemed as active as when first captured. On the following day at 9.30 a.m. a fresh supply of wet blotting paper was placed in her cage when in less than sixty seconds she alighted upon it and assumed the same extraordinary attitude as on the previous evening at 6 p.m., collapsing immediately and placing her legs so that the middle and hind pairs were crossed behind the abdomen, the front pair remaining almost in a normal position. The abdomen was then elevated and extended to the full and three eggs were laid at short intervals. Each egg appeared under the lens as a tiny translucent drop of fluid and was ejected with considerable force to a distance equal to about three times that of the length of the abdomen. This process lasted for about two minutes, and afterwards the female crawled slowly away and up the side of the box, appearing weak and fatigued. Here she remained almost motionless for nearly three hours, gradually raising the whole of the body until it assumed a normal resting attitude.

On removing the blotting paper which had been placed in the cage the previous evening, seven additional eggs were found and these were evidently laid the previous evening when the insect was observed to go through the evolutions which have just been described. At 12.30 a.m. the same day she repeated the process when freshly moistened blotting paper was supplied. On this occasion two eggs were laid and these were found attached together side by side. At 5 p.m. two additional eggs were laid, the same curious attitude being assumed as before, but although frequently supplied with fresh wet blotting paper she did not produce any more eggs, and at 10 p.m. she died. On making an examination of the abdomen it was found to contain eight fully developed ova so that it is quite evident that this female had laid eggs elsewhere and previously to her capture.

The act of oviposition was seen on subsequent occasions, but in two instances the females died after remaining in a collapsed condition for periods of two and a half hours, and three hours and three-quarters, respectively. Both examples had their abdomens well filled with ripe ova and had apparently not laid any eggs before they were captured.

Synopsis of Maltese species of Phlebotomus.

A. Abdominal hairs recumbent.
   (a) Integument black. Large species. Palpi with second segment slightly longer than the third. *nigerrimus*, sp. n., p. 68.
   (b) Integument ochreous. Small species. Palpi with second segment one half the length of the third. *minutus*, Rond., p. 69.

B. Abdominal hairs more or less erect.
   (a) Legs in both sexes relatively short, average length of hind leg, 3 mm. Terminal segment of superior clasper of male slightly longer than the inferior clasper. *perniciosus*, sp. n., p. 70.
   (b) Legs in both sexes relatively long ; average length of hind leg, 4 mm. Terminal segment of superior clasper of male scarcely half as long as the inferior clasper. *papatasii*, Scop., p. 73.

Phlebotomus nigerrimus, sp. n.

Female.—*Colour*. Head, thorax, and abdomen brownish black ; hairs bright ochreous buff, those on the thorax being slightly paler and erect, those on the abdomen recumbent. Basal segment of antennae dark brown. Palpi pale to dark brown, hairs similar in colour to those on the body. Legs pale ochreous buff, with ochreous white, *not silvery white*, refulgence. Wings ochreous buff or dull golden in some lights.

Head. Proboscis long ; eyes black, deeply emarginate in front. *Palpi* and *antennae* very like those of *P. papatasii*. *Legs* very long, femur of hind pair nearly as long as the abdomen ; tibia one and one-third times the length of the femur ; tarsi longer than the tibiæ by about one-sixth, or nearly as long as the wing ; ungues simple. *Wings* (fig. 5, p. 62) with the hind margin strongly arched ; sixth longitudinal vein short, terminating near the centre of the hind margin, the length equal to the distance, in a straight line, from its tip to the tip of the third longitudinal vein ; the anterior branch of the second longitudinal vein twice the length of the distance between the two forks.

Length, 2·50 mm.

The black or brownish black colour of the integument of this insect will serve as a ready means of distinguishing it from any of its allies. It may also be separated from *P. papatasii*, to which it is closely related in its morphological characters, by the shape of the wing and the shorter sixth longitudinal vein. The only two examples which were secured were taken by Captain P. J. Marett; both are females, one of which bears the data : "Black species, Gozo, 20. X. 10 ;" the other, "*P. papatasii*, dark variety, 17. VI. 10. F."

Captain Marett had evidently therefore noted the black or dark colour of this insect in life ; and when questioned regarding this he was absolutely certain that the colour was not due to *post mortem* changes. It is undoubtedly a rare insect in the Maltese Islands, otherwise more specimens would have been secured. We trust that Captain Marett will be able to obtain examples of the males so that the characters of the armature may be examined and described.

ERRATUM.

In the Bulletin of Entomological Research, Vol. II., Part I, p. 68, lines 9 and 12, the characters of the claspers of the male given for *Phlebotomus perniciosus* and *P. papatasii* should be transposed.

Phlebotomus minutus. Rondani.

Male.—*Colour.* Integument rather opaque, dull golden ochreous. Antennae with black and ochreous hairs mixed. Head with the clypeal and occipital tufts of hairs pale ochreous. Thorax with a median mane-like tuft, a lateral tuft in front of the insertion of the wings and also a tuft on the scutellum, all pale ochreous with a golden tinge, but with a few intermingled black hairs. Abdomen densely clothed with recumbent, dull, golden ochreous hairs; those covering the genital organs intermingled with black hairs. Legs covered with scales which appear smoky brown in some lights, silvery ochreous in others. Hairs of the wing mixed black and ochreous, those of the costa not darker than those on the surface of the wing.

Head. Proboscis relatively short; clypeus hairy. *Antennae* with the third segment a little longer than the fourth, but not nearly so long as the fourth and fifth together; the long verticillate hairs extending to the apical segment. *Palpi* (fig. 13) with the second segment one half the length of the third; the

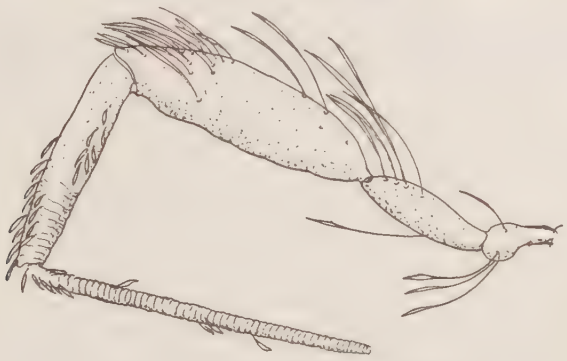

Fig. 13. Palpus of *Phlebotomus minutus.*

latter much the stoutest and broadest; dorsally it appears incrassate towards the base; fourth segment not quite so long as the third; fifth much the longest. *Wings* (fig. 7, p. 62) very narrow, and bluntly lanceolate; divided into two almost equal halves by the third longitudinal vein; the upper or anterior branch of the second vein shorter than the distance between the two forks. *Legs.* Hind pair a little more than three times the length of the abdomen inclusive of the genitalia; tarsus a little longer than the tibia.

External genitalia (figs. 14, 15) small; superior claspers with four long spines: two apical and two subapical: inferior claspers very slightly swollen in the middle; intermediate appendage similar to that in *P. papatasii*; intromittent organ nearly three-fourths the length of the inferior claspers; genital filament not protruding.

Length, 1·5–1·65 mm.

Female.—*Colour.* Wings with a distinct black costa and fringe; wing-area also with numerous black hairs intermixed with the ochreous ones. Legs with the femora ochreous beneath, darker above; tibiæ and tarsi blackish, with silvery grey scales. Thoracic and abdominal hairs as in the male.

Antennæ with the long hairs extending to the tip, the third to the ninth segments, inclusive, with geniculated and paired spines. *Palpi* as in the male.

Length, 2 mm.

The distinguishing characters of this insect are its relatively small size, especially in the male; the recumbent abdominal hairs; the short third antennal segment; and the marked character of the palpi. The male may be easily distinguished also by the form of the external genitalia.

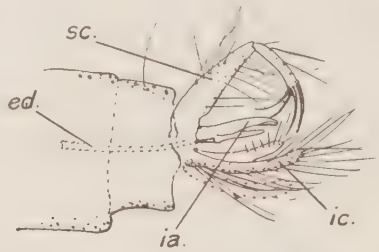

Fig. 14. External genitalia of *Phlebotomus minutus*, ♂; *sc*, superior claspers; *ic*, inferior claspers; *ia*, intermediate appendages; *ed*, ejaculatory duct.

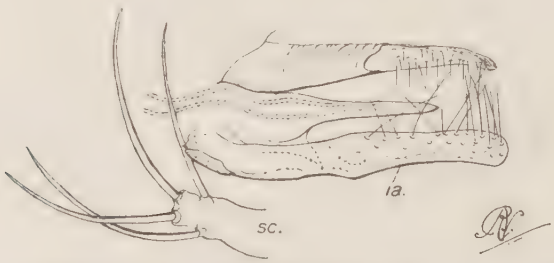

Fig. 15. Superior clasper (*sc*) and intermediate appendages (*ia*) of *Phlebotomus minutus*, more highly magnified.

The first two examples were captured by Major F. L. Dibblee, Royal Marine Artillery, at his residence at Sliema, August 20th, 1910; and two additional specimens were taken by myself, one at Casa Leoni, in a rabbit hutch, August 31st; the other at Floriana, August 27th.

In captivity *Ph. minutus* is much more active than any of the other Maltese species, and when confined to a small area was almost incessantly moving from place to place. Apart from its flea-like actions it also has the remarkable habit of whirling round and round with great rapidity, so rapidly at times as to render itself almost invisible.

Phlebotomus perniciosus, sp. n.

Male.—*Colour immediately after death.* Eyes black. Thorax with or without dull red-brown spots; when present they are arranged in a triangle, and there is occasionally a similar spot on the vertex of the head. Thorax and

coxae pale, translucent ochreous; abdomen similar, but sometimes pale smoky grey. Hairs pallid. Wings faintly irridescent in strong light; pale drab in subdued light; costal fringe generally very dark or blackish grey, though examples with pale costal fringes are not uncommon. Legs silvery grey, in a strong light presenting a distinct metallic lustre; in certain lights also those segments which lie in shadow appear almost black and show up in marked contrast to those which are so placed that their surfaces refract the light. In some lights the under surface of the legs appears distinctly and regularly speckled, a character due evidently to the regular arrangement of the scales.

Head densely hairy, with generally two ill-defined tufts. Clypeus with a large tuft of hairs, some of which are directed forwards, others backwards towards the forehead. *Palpi* with segments 2, 3 and 4 equal in length and collectively a little longer than 5. *Antennae* with the second segment much longer than the two succeeding ones; the longest hairs on segment 14 almost equal in length to those on the preceding segment. *Thorax* densely hairy, usually with a tuft on the front portion and another on the scutellum. *Abdomen* densely hairy, the longest hairs arising from the apical margin of the segments, but no distinct tufts are found as in *P. papatasii*. The arrangement of the hairs is similar in both sexes, but blackish hairs are often intermixed with the pale ochreous ones on various parts of the body in the darker forms of this insect. *Legs* shorter than those of *P. papatasii*. *Wings* (fig. 6, p. 62) with the posterior border much more strongly arched than the anterior border; the anterior branch of second longitudinal vein nearly as long as the stem between the cross-vein and the proximal fork.

External genitalia (figs. 16, 17). Superior clasper with five very long stout curved spines; two apical, one external and two internal, placed a little in advance of the outer one; inferior clasper nearly twice the length of the intermediate appendage and clothed to the apex with very long and slender hairs; intermediate appendage somewhat finger-shaped and hairy, proximal portion with a large keel-like extension ventrally, the distal margin of which bears several (5–6) hairs; apex of intromittent organ deeply divided or forked, with occasionally a minute central tooth; exposed portion of the genital filament about half the length of the intromittent organ.

Female.—With the palpi, antennae and legs similar to those of the male. Wings very slightly larger and broader than those of the male.

Length, 1·9–2·2 mm.

This insect is widely distributed over the island of Malta, and was extremely abundant during the month of August and the beginning of September, though many examples were captured also in July. It was most abundant at Floriana, near the old bastion by the Grand Harbour, on the evenings of August the 26th and 27th, when, between the hours of 8.30 p.m. and 9.30 p.m., 39 examples were captured as they came into a lighted room; of this total 28 were males and 11 females.

Two examples of *P. minutus* were found in association with this species; but strange as it may seem, not a single example of *P. papatasii* was either captured or seen on these occasions.

It was common also during the last week in August at Casa Leoni, the residence of the Hon. E. C. Roupell, D.S.O., Acting Lieutenant-Governor. In this place it was found most abundantly in a large outhouse which was tenanted by a number of rabbits. In the early mornings, shortly after 6 a.m., numbers of sand-flies were found chiefly in the corners of the room, but many were also seen sitting about the walls in various places, though chiefly at the junction with the ceiling. Later in the day they were rarely seen in these situations; but examples could always be found in the dark earthen pots which were used, and generally occupied, by the rabbits as retreats.

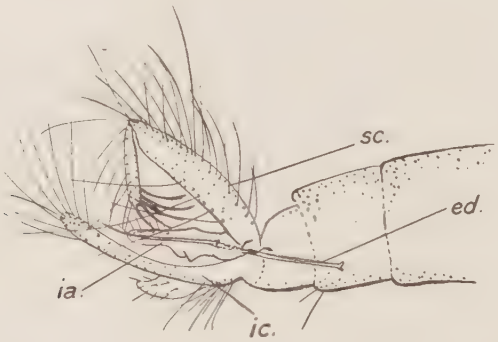

Fig. 16.—External genitalia of *Phlebotomus perniciosus*, ♂; *sc*, superior claspers; *ic*, inferior claspers; *ia*, intermediate appendages; *ed*, ejaculatory duct.

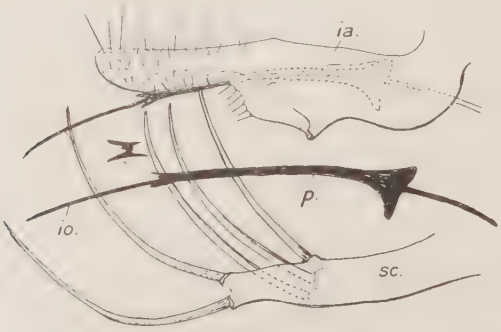

Fig. 17.—Portion of genitalia of *P. perniciosus*, ♂, more highly magnified; *sc*, superior claspers; *ia*, intermediate appendage; *p*, penis; *io*, intromittent organ.

The male is easily distinguished from that of *P. papatasii* by its generally smaller size, shorter legs, and much smaller genital armature, which is little more than half the width of the abdomen. The female may also be distinguished by its shorter legs, and generally darker colour. After a few hours in captivity it also becomes generally much less active than *P. papatasii*, though it has the same hopping flight so characteristic of these insects.

Pupa (Pl. II, fig. 4).—Abdomen distinctly and sharply curved upwards so that a somewhat S-shaped outline is produced; thorax gibbose; abdominal

segments each provided with a *pair of very large tubercles* (Pl. II, fig. 5), the tips of which are furnished with a pair of broad flat appendages ; integument thickly covered with squamose spines (Pl. II, fig. 4).

The larval skin attached to the pupa does not present any morphological differences from that of *P. papatasii*, as far as one can gather from its shrivelled condition. It possesses the same kind of caudal bristles and hairy body-spines.

Phlebotomus papatasii (Scopoli).

Bibio papatasii, Scopoli, Deliciae faun. et flor. Insubriciae, I, p. 55, Pl. XXII, fig. B. a. b. (1786).

Cyniphes molestus, Costa, Storia dei lavori dell'Acad. Aspir. Natural., Artic. Zool. (1840) ; id., Annali dell'Acad. Aspir. Natural. I, p. 4 (1843).

Hæmasson minutus, Loew (*nec* Rondani), Stettin. Ent. Zeit. V, p. 115, Pl. I, fig. 1–5 (1844).

Phlebotomus papatasii, Grassi, Mem. d. soc. Ital. d. Sci. (3) XV, p. 353 (1907).

This insect has been described so frequently that it seems unnecessary here to do more than add such particulars as have hitherto been overlooked, or imperfectly dealt with. In the first place it may be noteworthy to state that there are two distinct colour varieties of this common and widely distributed species :—

(1.) A uniformly pale form, which may be considered typical ;

(2.) A form which differs from the foregoing in having a dark coloured fringe to the costa and hind margin of the wing ; herein described as the dark form.

Female.—*Typical pale form* (immediately after death).—Almost uniformly pale translucent ochreous, thorax with a long dull red-brown median stripe, and a single spot of the same colour on either side, near the front margin of the thorax. Hairs on all parts of the body greyish, their arrangement similar to that of the male. Wing relatively broad (fig. 4, p. 62). Wing-fringe not markedly darker than the hairs on the disc of the wing.

Male.—*Typical pale form* (immediately after death).—Colour similar to that of the female. Clypeus with a tuft of 8–10 hairs ; head with a loose tuft, some of the hairs curving forwards, others backwards ; tuft on nape of slightly longer ones, chiefly curved forwards. Thorax densely clothed ; the hairs arranged in loose tufts. Wing much narrower than in the female (fig. 4, p. 62). Abdomen uniformly hairy, with small tufts on the dorsum arising from the apical margin of each segment ; superior claspers densely hairy, with a few black hairs intermixed with the pale ones ; these hairs are easily deciduous, with the exception of a large tuft which is more or less permanent in examples mounted in Canada balsam.

Female.—*Dark form.* General colour similar to that of the pale form. Wing fringes distinctly smoky grey ; some of the hairs on the veins are also dark grey or smoky grey.

Male.—*Dark form.* Not observed.

This form is not uncommon; but is very much rarer than the dark form of *P. perniciosus.* It does not differ structurally from typical pale examples so that the following description of the palpi and antennae applies to both varieties.

Palpi of five segments; 1 very short, slightly dilated distally; 2 a little longer than the succeeding one; 3 decidedly broader than the rest; 4 a little shorter than 3; 5 as long as or slightly longer than 2; 1 to 3 hairy; 4 and 5 scaly and with a few fine hairs. *Antennae* (fig. 2, p. 58) of 16 segments; 1 and 2 the stoutest, the former with one side longer than the other, the latter bead-like; 3 much the longest, being equal in length to the last five segments together; 4–13 each very slightly shorter than the preceding one respectively; 14 to 16, inclusive, more strongly incrassate (swollen) basally than the rest; all the segments with the exception of 1 and 2 densely clothed with hairs, the longest of which arise from the incrassated portion of each segment, except on the terminal segments which are furnished with hairs of equal length; 4 to 15, inclusive, also furnished with a pair of stout spines (fig. 2), which are suddenly elbowed or bent at right angles to their insertion so that for nine-tenths of their length they lie practically parallel with the surface of the segment to which they are attached.

The external genitalia of the male are much larger than those of any of the other Maltese species; a character which may be readily recognised in life, under a low magnification. The morphological characters are shown in the accompanying illustration (fig. 18).

Length, 2·5–2·65 mm.

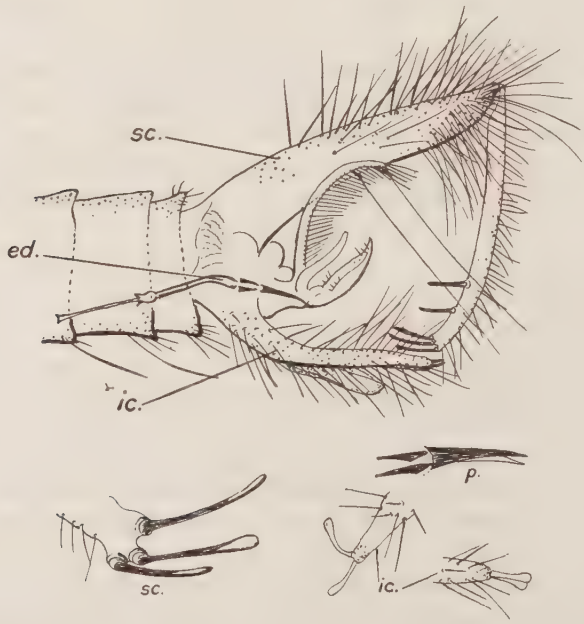

Fig. 18.—External genitalia of *Phlebotomus papatasii*, ♂; *sc*, superior claspers; *ic*, inferior claspers; *ed*, ejaculatory duct; *p*, penis.

In captivity this insect is much more restless than *P. perniciosus*, so much so that after a few hours one may readily distinguish the two species by this alone, apart from the other characters ; *i.e.*, the generally larger size, paler colour, and much longer legs of *P. papatasii*.

Ovum (Pl. I, figs. 1–5).—When forcibly expelled from the body a day or so before the cuticle has become opaque the interior (oolemm) can be seen ; and in such examples also the micropyle is distinctly visible as a short ring-like extension at the anterior pole of the egg. The oolemm at this stage is filled with globular particles of fatty matter, suspended in a structureless matrix. When first laid the egg is translucent white and covered with a thin coating of viscous matter by which it readily adheres to the surface upon which it may fall ; five hours after it has been laid it assumes its normal form and colour, which may be described as follows :—Form very elongate, dark brown, shining, with longitudinal black wavy lines, which in certain lights give the periphery of the egg a faintly rugose appearance ; these black lines are slightly raised and are joined by slender cross-lines so that a faint but rather coarse reticulation is formed. The transverse lines are however, very difficult to trace unless they are illuminated by a strong beam of light.

The incubation period lasts for about nine days : but unless kept in a moistened atmosphere the eggs will not hatch.

Larva.—*First instar* (Pl. I, fig. 8). Cylindrical and distinctly caterpillar-like in its general form ; head black : body white or ochreous white : caudal bristles, long, black. Head (fig. 19) very broadly pyriform : frontal hairs two in number, simple ; dorsally there are three similar hairs on each side ; one arising from the mid-region of the mandibles, one near the base, and a slightly longer one towards the centre of the head, near the margin ; besides these there are at least four hairy spines on each side, arranged as shown in the illustration. Antennae (fig. 19, *ant.*) composed apparently of three segments, the first two being quite rudimentary and ring-like ; third segment broad, flat and ovate in outline, the anterior edge faintly emarginate and furnished with a centrally placed hair. Mandibles (fig. 19, *md*) large and provided with four distinct but rather blunt teeth, of which the apical one is much the largest. Labial plate (fig. 19, *lp*) somewhat triangular in outline, with four teeth on each side, the median ones being much the largest ; in its general form the labial plate resembles those found in the larvae of the Culicidae. Articulations of the body clearly defined ; each segment bears from four to five hairy spines on each side, all of which are broadly dilated apically. Caudal bristles in two pairs, one of which is much the longer, almost equalling the length of the body, the other pair extremely short.

Last instar (Pl. I, fig. 7). Form resembling that of the first instar ; colour pale ochreous white ; head black ; caudal bristles black, arranged in two pairs, each pair being attached to a large tuberculous process ; the inner bristle is much the longer, almost equalling one-half the length of the body of the larva ; all of these bristles, under a high magnification, present a number of extremely fine, equidistant, and intensely black surface lines, the intervening spaces being distinctly pale ; it is highly probable therefore that these bristles are finely striated,

but as no sections were cut it is impossible to determine their true structure by examining them in optical section only. Thoracic and abdominal spines (Pl. I, fig. 10) much longer and stouter than those in the earlier stages; apices *narrowly dilated* and transparent, the remaining portion clothed with minute stiff hairs; these hairy spines are arranged in more or less regular transverse

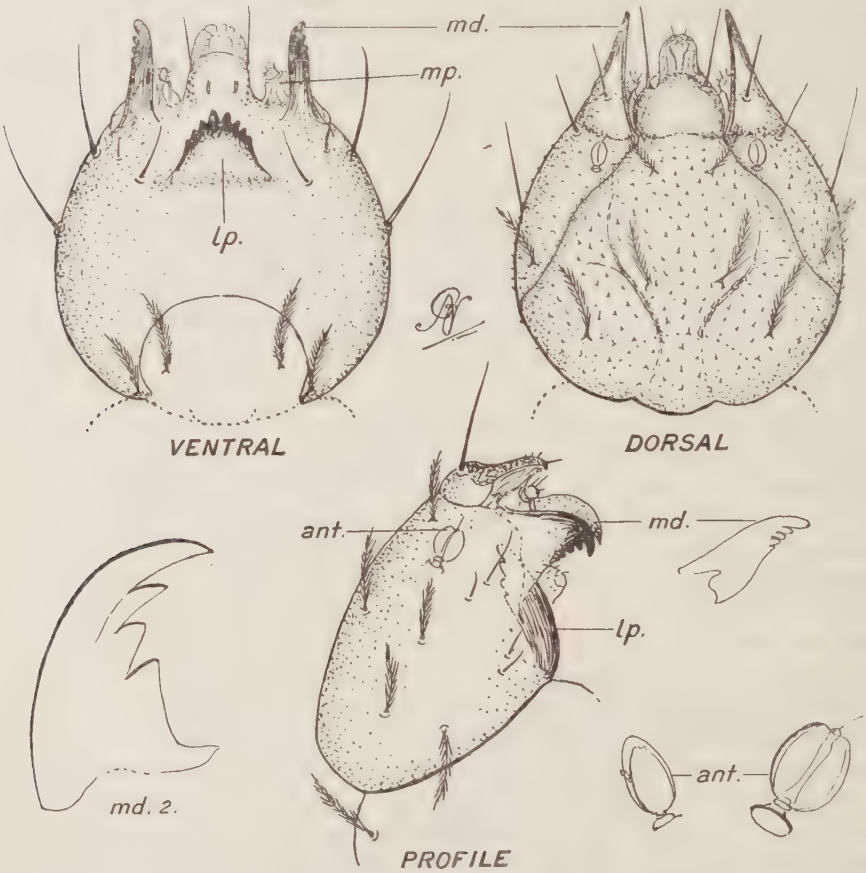

Fig. 19.—Head of larva of *Phlebotomus papatasii*. *ant*, antenna; *md*, mandible; *mp*, maxillary palpus; *lp*, labial plate.

rows, there being four or five on each side of the median line. Head with several large spines similar to those on the abdominal segments, but they are pointed instead of being dilated at the apex; besides these hairy spines there are also several rather long stout hairs, four of which are frontal. Sucker feet similar to, but relatively larger than, those in the first instar.

Length, 2–3·28 mm.

Pupa. (Pl. I, figs. 11, 12). When empty, clear ochreous buff. Eyes in life black. Abdomen curved upwards distally in varying degrees, but not apparently so distinctly S-shaped as in *P. perniciosus*; considerably wider in the thoracic region than at the distal segments of the abdomen: integument clothed with minute squamose spines (Pl. I, fig. 15), which are most conspicuous on the

abdominal segments. Thorax with two tubercles on each side, the anterior one bearing two or three long slender spines. Abdominal segments each with one (possibly two) extremely minute tubercles at the apex of which is a minute broad flat spine; those on the 7th and 8th segments more conspicuous than the rest; but all of these processes are so minute as to be easily overlooked. Wing-sheaths pointed apically and extending subventrally as far as the base of the 7th abdominal segment. Head distinctly elongated and somewhat triangular in outline; in the empty pupa this often breaks away in the process of mounting when the outline may be seen to bear a striking resemblance to the head of an ox in miniature (Pl. I, fig. 13). Antennal sheaths distinctly segmented, lying curved behind the eyes and subsequently following the costa of the wing-sheath. Palpal sheaths originating near the centre of the frons, extending backwards and then curving suddenly forward so that the apex rests against the antennal sheath and lies pointing in the same direction. Legs extending slightly beyond the wing sheaths.

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March 23rd, 1911.

EXPLANATION OF PLATE I.

Phlebotomus papatasii, Scop.

Fig. 1. Eggs, approximately natural size.
2. Egg, a few hours before extrusion, showing micropyle.
3. Egg, freshly extruded.
4. Egg, a few hours after extrusion.
5. Egg, much enlarged, to show reticulated surface.
6. Larva, approximately natural size.
7. Sketch of adult larva, enlarged.
8. Larva ; first instar, enlarged.
9. Stigma of larva with spine.
10. Hairy spine of larva.
11. Pupa, approximately natural size.
12. Pupa enlarged : *ls*, larval skin with anal bristles attached.
13. Front view of the head of the pupa : *e*, eye ; *a*, antenna ; *p*, palpus.
14. Thoracic tubercles of pupa.
15. Squamose body-spines of pupa.
16. One of the abdominal papillæ of the pupa.

R. Newstead, *ad. nat. del.* Bale & Danielsson, Ltd., *lith.*

PHLEBOTOMUS PAPATASII

EXPLANATION OF PLATE II.

Phlebotomus papatasii, Scop.

Fig. 1. Imagos, approximately natural size.
2. Male, enlarged ; from life.

Phlebotomus perniciosus, Newst.

3. Pupa, approximately natural size.
4. Pupa, enlarged.
5. One of the abdominal tubercles of the pupa.
6. Squamose spines of the abdominal segments of the pupa.

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PHLEBOTOMUS PAPATASII AND P. PERNICIOSUS.

EXPLANATION OF PLATE III.

Fig. 1. *Phlebotomus papatasii*, Scop., female, enlarged ; from life.
2. *Phlebotomus perniciosus*, Newst., female, enlarged ; from life.
3. „ „ approximately natural size.

[NOTE.—The above enlarged figures and that of the male shown on Plate II. are all drawn to the same scale.]

1.

2.

3.

R. Newstead, *ad. nat. del.* Bale & Danielsson, Ltd., *lith.*

PHLEBOTOMUS PAPATASII AND P. PERNICIOSUS.

EXPLANATION OF PLATE III.

Fig. 1. *Phlebotomus papatasii*, Scop., female, enlarged ; from life.
2. *Phlebotomus perniciosus*, Newst., female, enlarged ; from life.
3. „ „ approximately natural size.

[Note.—The above enlarged figures and that of the male shown on Plate II. are all drawn to the same scale.]

1.

2.

3.

R. Newstead, *ad. nat. del.* Bale & Danielsson, Ltd., *lith.*

PHLEBOTOMUS PAPATASII AND P. PERNICIOSUS.

A NEW FLY OF THE GENUS AGROMYZA FROM EGYPT.

By JAMES E. COLLIN.

Agromyza salicifolii, sp. n.

Belonging to the reptans *group; thorax dark dove-grey with a faint greenish tinge; abdomen dark green, shining; legs entirely black; wings hyaline, iridescent, with pale veins, squamæ whitish with white fringes, halteres pale yellow with a darkened stem.*

♂. *Head* in profile deeper than wide, frons not produced, eyes large, jowls at the lower angle of eye about equal in width to the length of third antennal joint, face and frons of a similar colour to thorax, frons longer than wide, sides parallel until opposite the antennæ where they slightly converge, sides of the face gradually diverging; face concave, with practically no keel or furrow, frontal lunule small, as in *reptans*; antennæ small, dull black, arista practically bare, palpi black, proboscis yellowish and yellow-haired, chaetotaxy of head as in *reptans*, but only four pairs of orbital bristles, the lowest pair converging, the minute hairs on ocellar triangle and along the eye-margins very inconspicuous. *Thorax* and pleuræ dark dove-grey with a faint greenish tinge, hardly shining, chaetotaxy as in *reptans*, but only two pairs of dorso-central bristles, the front one well developed and about in a line with the front supra-alar bristle; in addition to the usual strong sternopleural bristle, one or two bristles in front of it are fairly well developed. *Abdomen* shining dark green, ovate, flattened, rather pointed in both sexes, evenly clothed with short black bristles which are rather longer on the hind margins of the segments. *Legs* entirely dull black, femora with blunt apical ends, front femora with a row of bristles behind, mid femora with a bristle behind at the tip, middle tibiæ with two bristles behind on the middle third. *Wings* (fig. 1) ample, hyaline, and iridescent, appearing whitish in some lights,

Fig. 1.—Wing of *Agromyza salicifolii*, ♂. × 30.

all the veins yellowish especially towards the base of wing, the penultimate section of postical vein longer than the last section, anal angle and alula well developed. Squamæ white with yellowish margins and short white fringes. Halteres with pale yellow knobs and brownish stems.

♀. Difficult to distinguish from the male, the ovipositor being withdrawn within the last abdominal segment, and the tubular basal part very short.

Length $2\frac{1}{4}$—$2\frac{1}{2}$ mm.

The species of *Agromyza* are very difficult to name because very few have been described with sufficient accuracy, but there does not appear to be any species known with the characters given above; the extreme shortness of the tubular ovipositor, usually so conspicuous in the females of *Agromyza*, is somewhat remarkable.

A. salicifolii was bred by Mr. F. C. Willcocks, Entomologist to the Khedivial Agricultural Society, from mines in willow leaves found at Gizeh, Lower Egypt, in April, 1910.

INVESTIGATION INTO THE HABITS AND DISTRIBUTION OF TSETSE-FLIES.

The thanks of the Entomological Research Committee are due to the following gentlemen who have kindly forwarded information on the above subject, in response to circulars issued by the Committee :—

Mr. Henry Brown, Thornwood Estate, Mlanji, Nyasaland.
Mr. T. A. Budgen, Assistant Resident, Patigi, N. Nigeria.
Mr. A. Campbell-Irons, Assistant Resident, Lafia Division, Nassarawa Province, N. Nigeria.
Mr. C. A. Carand, Resident, Upper Shire District, Nyasaland.
Mr. T. F. Carlyle, Assistant Resident, Gombe Division, Bauchi Provinces, N. Nigeria.
Mr. M. H. Corsellis, Acting District Commissioner, Ogoja, Eastern Province, S. Nigeria.
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THE thanks of the Entomological Research Committee are due to the following gentlemen, who have kindly presented collections of insects (received between 1st October and 31st December, 1910) :—

Dr. W. S. Clark :—101 Culicidae, 49 Tabanidae, 82 *Glossina palpalis*, 2 *G. fusca*, and 2 *G. tachinoides* ; from Ikom District, Cross River, S. Nigeria.

Mr. R. David :—8 *Simulium* and 10 Hemiptera (*Nysius euphorbiae*) ; from Mauritius.

Mr. R. E. Drake-Brockman :—55 Diptera, 1 Flea, 5 Lice, 34 Coleoptera, 6 Coleopterous larvae, 6 Thysanura, and 43 Ticks ; from British Somaliland.

Mr. J. H. J. Farquhar :—12 Tabanidae, 4 *Glossina*, and 19 Lepidoptera ; from Oban, S. Nigeria.

Mr. J. A. de Gaye :—3 Tabanidae, 8 *Glossina palpalis*, 9 other Diptera, 19 Coleoptera, 110 Lepidoptera, 24 Rhynchota, and 2 Orthoptera ; from Lagos, S. Nigeria.

Mr. C. C. Gowdey :—14 Culicidae, 30 Tabanidae, 7 other Diptera, 6 Lice, 56 Coleoptera, 119 Hymenoptera, 12 Lepidoptera, 17 Rhynchota, various Coccidae, 12 Orthoptera, 80 Thysanoptera, 80 Ticks, and 51 Millipedes ; from various localities in Uganda.

Dr. W. M. Graham :—4 larvae and 4 pupae of *Pectinopalpus fuscus* ; from Lagos, S. Nigeria.

Dr. G. M. Gray :—3 Tabanidae, 83 other Diptera, 5 Siphonaptera, 8 Lice, 13 Coleoptera, 4 Hymenoptera, 1 Lepidopteron, 3 Hemiptera, 2 Neuroptera, and 3 Orthoptera ; from S. Nigeria.

Mr. J. A. Ley Greaves :—1 Tabanid and 23 *Glossina* ; from N. Nigeria.

Capt. L. E. H. Humfrey :—10 Culicidae, 1 Tabanid, 23 *Glossina*, 36 other Diptera, 4 Hymenoptera, 3 Rhynchota, and 1 Neuropteron ; from Ilesha, S. Nigeria.

Dr. A. Ingram :—175 Culicidae, 43 Tabanidae, 52 *Glossina*, 53 other Diptera, 1 Coleopteron, 5 Hymenoptera, 2 Lepidoptera, 2 Rhynchota, 3 Odonata, and 5 Orthoptera ; from Baro, N. Nigeria.

Mr. H. H. King :—2 Trypetidae, 2 larvae of *Hypoderma*, and 3 Coleoptera ; from the Anglo-Egyptian Sudan.

Dr. J. W. Scott Macfie :—246 Tabanidae, 5 *Glossina*, 13 *Stomoxys*, 9 *Lyperosia*, 22 Hippoboscidae, 97 other Diptera, 4 Coleopterous larvae, 3 Lepidoptera, 9 Rhynchota, and 3 Orthoptera ; from Zungeru, N. Nigeria.

Dr. T. F. G. Mayer :—165 Culicidae, 26 Culicid larvae, 2 other larvae, 53 Tabanidae, 44 *Glossina*, 2 *Stomoxys*, 582 other Diptera, 2 Lice, 2 Coleoptera, 46 Hymenoptera, 7 Rhynchota, 1 Neuropteron, 4 Orthoptera, and 7 Ticks ; from S. Nigeria.

Dr. B. Moiser :—75 *Glossina*, 2 other Diptera, 1 Coleopteron, 8 Hymenoptera, 1 Lepidopteron, 2 Rhynchota, and 1 Arachnid; from Maiduguri District, N. Nigeria.

Dr. W. Morrison :—3 Culicidae, 5 Tabanidae, 57 *Glossina*, 7 other Diptera, 14 Coleoptera, 15 Hymenoptera, 5 Lepidoptera, 4 Rhynchota, 10 Neuroptera, 15 Orthoptera, and 3 Ticks ; from Baro, N. Nigeria.

Mr. S. A. Neave :—33 *Glossina morsitans*, 23 other Diptera, 13 Siphonaptera, 3,140 Coleoptera, 1,185 Hymenoptera, 784 Rhopalocera, 203 Heterocera, 1,129 Rhynchota, various Coccidae, 113 Neuroptera, 263 Orthoptera, and 477 Ticks ; from various localities in Nyasaland.

Dr. J. E. S. Old :—24 Culicidae, 14 Tabanidae, 3 *Auchmeromyia luteola*, 283 other Diptera, 133 Siphonaptera, 156 Lice, 146 Coleoptera, 96 Hymenoptera, 30 Lepidoptera, 11 Lepidopterous larvae, 517 Rhynchota, 7 Neuroptera, 40 Neuropterous larvae, 45 Orthoptera, 581 Ticks, 21 Spiders, and numerous Galls ; from Blantyre, Nyasaland.

Dr. E. H. Allon Pask :—1 Jigger and 52 Ticks ; from Dowa, Nyasaland.

Dr. Meredith Sanderson :—4 *Chrysops*, 21 *Haematopota*, 3 *Tabanus*, 279 *Glossina brevipalpis*, 1 Hippoboscid, 44 other Diptera, and 1 Spider ; from Karonga, Nyasaland.

Mr. J. J. Simpson :—297 Culicidae, 121 Culicid larvae, 115 Tabanidae, 247 *Glossina*, 29 *Stomoxys*, 15 Hippoboscidae, 234 other Diptera, 5 Siphonaptera, 11 Lice, 246 Coleoptera, 145 Hymenoptera, 240 Lepidoptera, 73 Rhynchota, 4 Neuroptera, 23 Orthoptera, 208 various insect larvae, 285 Ticks, 2 Spiders, and 3 Centipedes ; from N. Nigeria.

Dr. C. E. S. Watson :—38 Culicidae, 52 Tabanidae, 95 *Glossina*, 1 Hippoboscid, 1 other Dipteron, 20 Coleoptera, 1 Hymenopteron, 1 Lepidopteron, 1 Hemipteron, 12 Neuroptera, 15 Orthoptera, and 1 Arachnid ; from N. Nigeria.

Mr. F. C. Willcocks :—39 Diptera, 38 Coleoptera, 1 Tenthredinid, 4 Ichneumonidae, 42 Micro-lepidoptera, and 34 Rhynchota ; from Gizeh, Cairo.

OBSERVATIONS ON AFRICAN SCALE INSECTS (COCCIDÆ).

(No. 3.)

By Robert Newstead, M.Sc., A.L.S., &c.,
The School of Tropical Medicine, The University, Liverpool.

The insects referred to in this paper were collected in various parts of Africa: those from Egypt by Mr. F. C. Willcocks, Entomologist to the Khedivial Agricultural Society, Cairo: those from Uganda by Mr. C. C. Gowdey, the Government Entomologist; and the remainder by Mr. S. A. Neave. The collections comprise several species which are known to be destructive to cultivated crops and fruits in various parts of the world: and others, judging by their numbers, must at least be considered of potential economic importance. Out of the total of 32 species, ten are new to science, and the lac-producing *Tachardia decorella*, Maskell, has not hitherto been recorded from Africa.

At present it is impossible for me to do more than describe the external characters of the newly discovered species: to notify the presence of others which may be found, from time to time, and to catalogue the names of the plants upon which they are known to occur. As there are few insects which are capable of causing greater damage to cultivated plants and fruits than scale-insects of various kinds, it is highly important that this portion of the work should be proceeded with as rapidly as possible, so that we may be in a position, in the near future, to present a comprehensive summary of the results.

It is important also from an economic standpoint, that the "scale" enemies of the indigenous plants should be investigated, as it has been frequently demonstrated that apparently unimportant species of Coccidæ have subsequently proved a serious menace to the cultivation of plants of various kinds in many parts of the world.

A study of the bionomics of these insects should prove of great interest and importance, but this must be left to entomologists who are resident in Africa.

Aspidiotus trilobitiformis, Green.

On Oleander: Kilossa, Usagara, German East Africa, 27. XII. 1910 (*S. A. Neave*).

As is usual with this species, the females were all arranged along the mid-rib of the leaves of the food-plant. The puparia are less deltoid in shape than other examples which I have seen from Africa (Dar-es-Salaam): but the morphological characters agree so closely with Green's description* that there can, I feel, be no doubt as to its identity.

Aspidiotus hederae, Vallot.

"On a small tree," Uhehe district, German East Africa, about 4,000 ft., 1. XII. 1910 (*S. A. Neave*).

Mr. Neave adds the following particulars:—"though nearly every leaf on the west side of the tree was infested with this Coccid, the east side, *i.e.*, that

* Coccidæ of Ceylon, p. 41.

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which was exposed to the prevailing wind, was almost free from it." Also on Magnolia, at Cairo,—May, 1908 (*F. C. Willcocks*); and on *Datura alba*, at Ghezireh, Cairo, 3. XI. 1910 (*F. C. Willcocks*).

Aspidiotus lataniæ, Signoret (=*A. cydoniæ*, Comstock).

On *Antigonon octopus*: Entebbe, Uganda, 22. IV. 1909 (*C. C. Gowdey*).

Diaspis (Aulacaspis) cinnamomi, var. **mangiferæ**, var. n. (fig. 1).

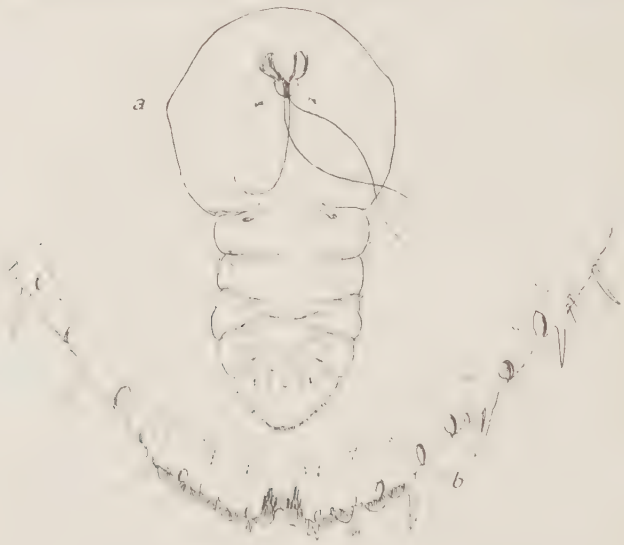

Fig. 1.—*Diaspis cinnamomi*, Newst. var. *mangiferæ*, Newst.; *a*, outline of female; *b*, margin of pygidium of adult female.

This variety differs from typical examples of *Diaspis cinnamomi*, Newst., in the following particulars:—The anterior lateral groups of circumgenital glands are much more numerous (26–29); the cephalothoracic area is considerably broader than the widest abdominal segment, and the median lobes are non-serrated. The puparia of the females are typical, and may be distinguished by the median black stripe in the larval pellicle.

On small mango trees imported from Ceylon; Gizeh, Egypt, 31. VIII. 1910 (*F. C. Willcocks*).

Diaspis regularis, sp. n.

Female puparium.—More or less circular: margins flat, narrow at the sides, and wide posteriorly; central portion highly convex; texture smooth and almost wax-like in appearance: colour yellowish white or creamy white, margins paler. Pellicles tilted forward: those of the larvæ marginal and straw-coloured; the second pellicles are similar in colour but have two dark brown or blackish, triangular areas on the abdominal segments: ventral scale absent. Diameter 1–1·15 mm.

Female, adult.—Broadly pyriform; abdominal segments suddenly attenuated. Rudimentary antennæ with two curved spines, but these are often broken away.

Parastigmatic glands generally absent, but a single one is sometimes present at the anterior stigmata. Margin of cephalo-thoracic region with a few widely separated, and minute spines. Pygidium with five widely separated groups of circumgenital glands ; formula :—

8	11	8
17 - 16	19 - 19	19 - 18
14 - 13	16 - 15	15 - 15

The last three abdominal segments with extensive groups of large dorsal pores ; and there are three or four much smaller ones on each of the two succeeding segments, near the margin ; fringe of pygidium (fig. 2) with three pairs of lobes ; the median pair recessed and smallest ; second and third pairs duplex, margins straight ; there is a large projecting pore between the first and

Fig. 2.—*Diaspis regularis*, Newst. ; margin of pygidium of adult female.

second and the second and third pairs of lobes, and two beyond them, these projections are distinctly lobe-like, so much so that they may be easily mistaken for true lobes. There is a large simple squama just in advance of the third duplex lobe and two beyond the last projecting pore ; those on the free abdominal segments are much the largest.

Male puparium.—Strongly tricarinate, texture close, thin and semi-transparent ; colour white, pearly white or greyish white ; pellicle pale ochreous or colourless. Length, ·75–1 mm.

Mubendi, Entebbe, Uganda, 10. VIII. 1909 (*C. C. Gowdey*). Food-plant not stated.

The puparia of both the males and females are all arranged with the greatest regularity and all pointing in the same direction upon the leaf. This is not a unique habit with the DIASPINÆ, but I do not remember having hitherto seen this character attained to such a marked degree in both sexes.

The boss-like puparia of the females are very distinctive ; and the fringe of the pygidium is also strikingly characteristic.

Diaspis cacti, Comstock.

On Prickly Pear (*Opuntia sp.*); Marg, Egypt, "Autumn, 1909" (*F. C. Willcocks*).

This insect has not hitherto been recorded from Africa, though the very closely related *Diaspis calyptroides*, Costa, has been found there.

Mytilaspis citricola, Packard (=*M. beckii*, Newm.).

On Citrus; Entebbe, Uganda, 3. II. 1910 (*C. C. Gowdey*).

Chionaspis longispina, sp. n.

Female puparium.—Varying from broadly ovate to elongate, and usually broadest immediately behind the exuviae or pellicles. The general colour of the scale is pale translucent grey; but many examples are bright ochreous brown, and there are also colour varieties intervening between these two; the puparia are, however, so completely concealed beneath the superficial layer of the bark of the food-plant that the true character of the secretion is rendered almost invisible. Pellicles dull yellow or orange yellow. Length, 1–1·25 mm.

Female, adult.—Form broadly ovate, the cephalo-thoracic region being as wide as the free abdominal segments. Rudimentary antennae with a single strongly curved and deeply forked spine. There are, apparently, no parastigmatic glands. Pygidium (fig. 3), strongly produced and furnished with two pairs of lobes; the median pair large, and, in well preserved specimens, tridentate on the anterior

Fig. 3.—*Chionaspis longispina*, Newst.; margin of pygidium of adult female.

lateral margin, the dentations being broadly rounded; second pair of lobes small and dentate on the outer lateral margin only. Squamae more or less rudimentary. Spines very long and slender, with the exception of the median pair which are minute and do not reach as far as the tips of the lobes. Body-wall with one bilateral pair of incisions, each surrounded by a circular patch of dark chitin. Circumgenital glands three to four in number, arranged in a single curved row. Anal orifice towards the margin of the pygidium. Sexual orifice almost centrally placed.

On *Justicia alba;* Ghezireh, Egypt, 2. IX. 1910 (*F. C. Willcocks*).

The distinguishing characters of the female are the long slender spines on the pygidium; the curious form of the antennal spines; and the absence of grouped circumgenital glands.

The "mining" habits of the female are rather striking, though many species insinuate themselves beneath the living cuticle of their food-plants, so much so in *Chionaspis biclavis*, Comstock, as to render the puparium quite invisible.

Scattered among the females were a number of male puparia which from their general form and colour are, I believe, referable to the genus *Parlatoria*, and

are in all probability those of *P. blanchardi*, Targ-Tozz. These are pale buff or ochreous in colour, short and stumpy in form, and the pellicles are smoky green or bottle-green in colour. They do not, in any measure, agree with the male puparia of any known species of *Chionaspis* with which I am familiar.

Chionaspis cassiae, sp. n.

Female puparium.—White, very highly convex and distinctly mytiliform; generally with distinct transverse layers of the dusky, yellowish brown, epithelial cells and long hairs from the food-plant incorporated with the secretion. Larval pellicles pale orange-yellow; second pellicles paler, and generally completely covered by secretion. Length, 2–2·50 mm.

Female, adult.—Apparently ovoviviparous, as several fully developed larvae were found in the body of the parent. Shape, normal. Rudimentary antennae with two rather long slender spines placed closely together so that they often appear as a single stout spine. Parastigmatic spines 5–7 in number, forming a small compound group near the orifice of the stigmata. Dorsal pores extending as far as the thoracic region; these organs are arranged, as usual, in scattered and somewhat indefinite bands broadening towards the margins of each segment, with the exception of the last in which they are placed much more closely together, forming definite narrow bands, widely separated in the median line. Pygidium with a similar band of pores, and five groups of circumgenital glands, the formula of which is as follows :—

8	11		6		9
21 – 19	26	17	?	– 20	20 – 22
28 – 27	32	20	? 21	– 27	24 – 27

median lobes (fig. 4) distinctly bilobed and apposed basally. Squamae spinose and

Fig. 4.—*Chionaspis cassiae*, Newst.; margin of pygidium of adult female; *a*, dorsal view; *b*, ventral view.

arranged in five bilateral pairs; the first pair covering the lateral margins of the median lobes, being much the smallest.

Puparium of male.—Pure opaque white; with widely separated *transverse ridges* or carinae, each ridge being curved towards the distal extremity of the puparium. Pellicles bright yellow. Length, 1–1·50 mm.

On *Cassia floribunda*; Entebbe, Uganda Protectorate, 1. VIII. 1910 (*C. C. Gowdey*).

The curious form of the male puparium should at once serve to distinguish this insect from any other member of the genus *Chionaspis*, typical forms being more or less distinctly tricarinate. In this species, however, there is no trace of the usual longitudinal ridges, which is remarkable, seeing that hitherto little variety has been found in the form of the male puparia.

The female belongs to that section of the genus in which the median lobes are in close apposition; it does not possess any very striking morphological characters but is apparently distinct.

Chionaspis substriata, Newstead.

On Palm; Entebbe, Uganda, 18. VI. 1909 (*C. C. Gowdey*).

Chionaspis dentilobis, Newstead.

Uganda (*C. C. Gowdey*). Food-plant not stated.

Fiorinia africana, sp. n.

Female puparium.—Somewhat ovate but suddenly narrowed posteriorly: widest and very highly convex in the region just behind the larval pellicle. Colour varying from pure white to smoky grey; the secretionary matter is pure white, but when the layer over the exuviae of the second stage female (second pellicle) is thin, the dark colour of the underlying insect shows through, giving the puparium a smoky grey tinge. Over-crowded examples of the puparia become distorted and irregular in shape as in other DIASPINAE under similar conditions. Larval pellicle usually ochreous buff, often with a small bottle-green spot at the caudal extremity. Second pellicle piceous or dark castaneous sometimes with a dull crimson area in the centre, the colour is, however, very variable.

Female, adult.—Pygidium (fig. 5) with an irregular arched group of circum-

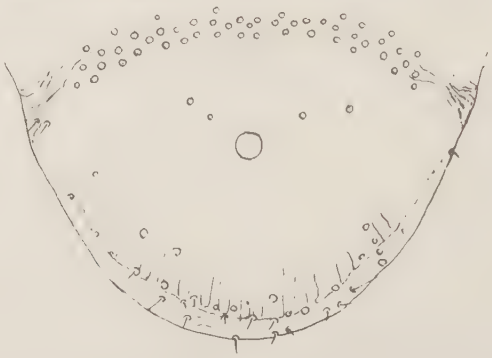

Fig. 5.—*Fiorinia africana*, Newst.; pygidium of adult female.

genital glands near its articulation with the first (distal) free abdominal segment; margin with (? several) simple quadrate lobes, and a number of short spines.

Female, second stage (nymph).—Somewhat pyriform in shape, with the abdominal segments gradually tapering towards the pygidium; each segment

five in all, with a single minute spine. Pygidium (fig. 6) strongly produced. Median lobes strongly bilobed, the outer lobe angular and tooth-like, the inner lobe square at the tip: on either side of the lobes are four large tooth-like projections and at the base of each pair a large secreting pore; there are also four similar marginal pores extending beyond them. Spines minute, one pair on both

Fig. 6.—*Fiorinia africana*, Newst. ; pygidium of second stage female (nymph).

dorsal and ventral surfaces at the base of the median lobes, and a single one between the third and fourth tooth-like projections. Anal orifice central. There are a few isolated, circular glands, and a single bilateral pair towards the centre of the margin which are united by a spirally striated thickening of the body wall: there are also four similar chitinous patches, but in these the striae are more or less longitudinal. Length, 1·75–2 mm.

Male puparium.—Relatively large, sides more or less parallel, convex for the greater part, but with the posterior extremity flattened. Pellicle usually bottle-green, but a few examples are dull greenish yellow; in some instances they occupy an almost oblique position: in others they are parallel with the secretionary portion. Normally they are straight, but in a very large percentage of cases they are curved or contorted owing chiefly to over-crowding or to the nature of the bark upon which they are fixed.

On poplar trees: Garden of the Horticultural Society, Gizeh, Egypt, March, 1910 (*F. C. Willcocks*).

All attempts to separate the adult female from the interior of the nymphal skin (second stage female) having so far failed, it has been impossible to define all of the morphological characters. Judging from what one has been able to see of the pygidium through the integument of the nymph, this insect is clearly distinct from any hitherto described species, and structure of this part in the nymph will at all times serve as a ready means of determining the insect.

Parlatoria (Websteriella) zizyphi, Lucas.

"On orange trees imported from Malta"; Egypt (*F. C. Willcocks*).

This pest of the orange and other species of Citrus, cannot be considered as newly introduced into Egypt, as examples have been previously received from this country. Moreover, it has a very wide distribution, and is found in nearly all the orange-growing countries of the world. It is one of the citrus pests in Malta, and is there generally distributed over the whole Island.

Parlatoria (Websteriella) ? blanchardi, Targ.

On Mis-mish (Apricot) ; Ghezireh, 2. IX. 1910 (*F. C. Willcocks*).

The examples are not quite typical either in the form of the female puparia or in the character of the fringe of the pygidium. It may be necessary, therefore, at some future date to make it a variety of the above-named species ; but it is advisable to examine a longer series of *P. blanchardi*, from various food-plants, before taking this step.

Lecanium (Saissetia) nigrum, Neitner.

On *Ficus* sp. ; Uganda Protectorate (*C. C. Gowdey*). No other data given.

The leaves to which these insects were attached were also tenanted by the very interesting Coccid herein described as *Ceroplastodes gowdeyi*, sp. n.

The examples are unusually pale, and the median ridge well defined ; but I do not find that they differ morphologically from typical examples of *L. nigrum*.

Lecanium elongatum, Signoret (= *L. longulum*, Douglas).

On *Albizzia* sp. ? ; Entebbe, Uganda, 6. X. 1910 (*C. C. Gowdey*).

Lecanium tenuivalvatum, sp. n.

Female, adult.—Narrowly elliptical and slightly produced in front ; highly convex ; margin narrowly flattened in front and at the sides, broadly so posteriorly ; dorsum smooth and shining ; sides distinctly wrinkled. Colour of parasitised examples black, with pale margin ; non-parasitised examples pale ochreous buff. Antennae short (fig 7, *a*, *b*) of 6 or 7 segments. Legs short ;

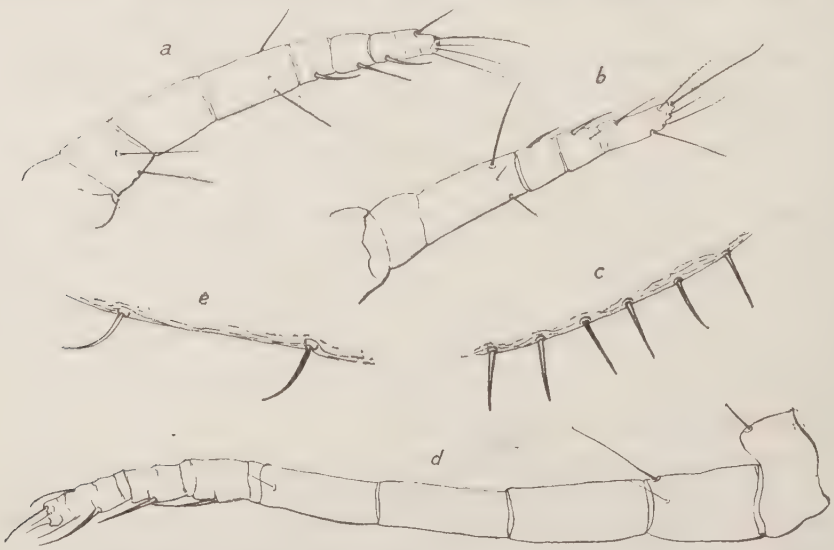

Fig 7.—*Lecanium tenuivalvatum*, Newst. ; *a b*, antennae ; *c*, marginal spines.
Lecanium elongatum, Sign. ; *d*, antenna ; *e*, marginal spines.

anterior pair scarcely longer than the antennæ. Anal lobes attenuated; apices with several stout spines; and there is a single and very long slender spine, arising from the ventral surface, the tip of which projects beyond the apex of the lobe. Stigmatic clefts shallow; spines rather short and bluntly pointed, central one a little more than twice the length of the two laterals. Marginal spines (fig. 7, *c*) long; they are also set closely together and are less deciduous on the cephalic margin than elsewhere. Derm cells minute, simple, and very widely separated. There are a few minute spines just in advance of the anal lobes. Length, 1·75-2·50 mm.

On Citronella grass; Entebbe, Uganda, 25. II. 1910 (*C. C. Gowdey*).

The insects were so numerous that they almost covered the leaves of the food-plant; and although so abundant quite 98 per cent. of them had been destroyed by a Chalcidid parasite; it is highly probable, therefore, that the markedly convex nature of the body was caused by the parasites, so that too much importance cannot be attached to this character.

This Coccid somewhat resembles a minature example of *Lecanium elongatum*, Signoret, but is clearly distinct; apart from its small size it may be easily distinguished by the character of the antennæ, and the closely set marginal spines.

I am extremely indebted to Mr. E. E. Green for giving me the opportunity of describing this insect; I have pleasure also in adopting the MS. name which he has given to it. Figures of the antenna and marginal spines of *Lecanium elongatum*, Signoret, (fig. 7, *d*, *e*) have been added for convenience of reference.

Lecanium (Eulecanium) tremæ, Newstead.

On "Nsambyia"; Palissa, Uganda, 1. XII. 1910 (*C. C. Gowdey*).

This species was described, quite recently, from examples collected by Prof. A. Zimmermann, at Amani, German East Africa. The females bear a strong superficial resemblance to *Lecanium persicæ*, but may be readily distinguished by the very distinct and strongly rounded ridge to the margin, as well as by other important morphological characters.

Pulvinaria jacksoni, Newstead.

On Cotton; Kyerime, near Lake Salisbury, Uganda, 10. XII. 1910 (*C. C. Gowdey*).

This remarkable Coccid has hitherto been recorded* only from the West Coast of Africa, where it was found infesting Cacao and a species of *Ficus*. In my original description of the insect, I called attention to the presence of two large flaccid tubercles in the stigmatic clefts as being one of the marked specific characters. In the examples from the Uganda Protectorate these processes are not visible, but I believe, however, that they have been completely destroyed by excessive maceration in the caustic potash. However this may be, the great length of the ovisac and its curious fungoid appearance will serve at once to distinguish this from any other known species of the genus.

* Journ. Econ. Biol. 1908, Vol. II., No. 4, p 155.

Pulvinaria psidii, Maskell.

On *Alternanthera versicolor*, Entebbe, Uganda, 1. VIII. 1910 (*C. C. Gowdey*); and on Coffee, Mabira Forest, Uganda, 15. IX. 1910 (*C. C. Gowdey*).

Judging by the number of females present upon the leaves submitted, this insect must cause serious injury to the coffee plant.

Ceroplastes ugandæ, sp. n.

Test of old adult female.—Hemispherical, surface uneven and coarsely wrinkled, due evidently to shrinkage; not divided into "plates;" lateral margin on each side with a short and very broad arm-like extension which slightly overlaps the branch, if a slender one, to which the insect is attached; posterior portion may be broadly bilobed and slightly recurved. Colour dull crimson with irregular greyish ochreous areas, the latter being probably due to abrasions of the surface. In the comparatively fresh examples, the wax yields to pressure and contains a large percentage of moisture. In the very old examples, the test becomes brittle and cellular. Length, 13–14; width, 11–12; height, 11–12 mm.

Female, adult.—Hemispherical, dorsum obconical, with a very distinct tubercle, the apex of which is furnished with a minute sharp ridge; there is a similar ridge-like tubercle on either side of the rudimentary caudal process, and one also over each of the posterior stigmatic clefts. Cephalic lobe, strongly produced in the young adult female, much less so in old examples. Derm uniformly and strongly chitinised; piceous; surface almost covered with rather widely separated papillæ;* by transmitted light these papillae appear as small ovate glands (fig. 8, *b*) in examples which have been macerated in potash. Stigmatic clefts (fig. 8, *a*) rather shallow, and immediately above them is a large broadly ovate

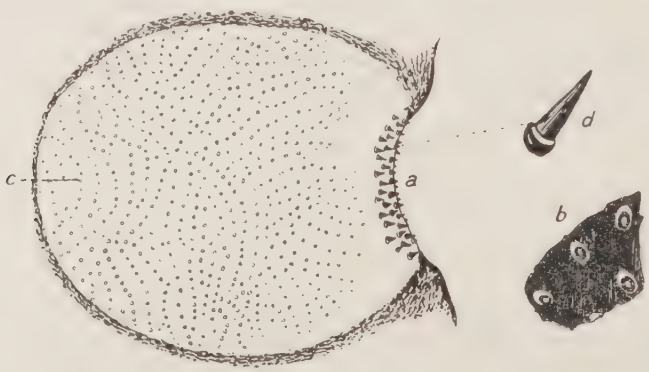

Fig. 8.–*Ceroplastes ugandæ*, Newst; *a*, stigmatic cleft; *b*, dorsal pores; *c*, parastigmatic glands; *d*, spine of the stigmatic cleft.

group of circular pores (fig. 8, *c*). Spines (fig. 8, *d*) short, simple and not confined to the margin. Diameter, 7–8; height, 6–7 mm.

On "Amakebe," Uganda (*C. C. Gowdey*).

* These are absent in a parasitised female, and the derm is thin and much more highly polished.—R. N.

The paper wrappers in which the specimens were packed were all stained dull crimson from contact with the waxen tests of these insects. *Ceroplastes quadrilineatus*, Newst., also produces a similar dye when crushed: but although the tests of these two species are almost identical in colour, there is no trace of the four white lines in *C. ugandæ*. Moreover, the female of the latter may be easily determined by the papillate character of the derm, and the distinct central and lateral tubercles.

Ceroplastes galeatus, sp. n.

Test of adult female.—Wax hard: creamy white or dusky yellowish white: roughly hemispherical: divided into distinct plates; dorsum with a central dark nuclear spot situate in a deep depression, the latter extending as a narrow groove as far as the region of the anal lobes; lateral plates separated by dark depressed lines; lateral margins over the stigmatic clefts projecting considerably beyond the hemispherical portion, in the form of two peak-like extensions, on both surfaces of which are the opaque white stigmatic bands; area surrounding the anal orifice almost denuded, so that the colour of the insect is visible. Width, 4·50–5; length, 4–4·50 mm.

Female, adult.—Hemispherical: shining and uniformly castaneous; cephalic lobe strongly defined; stigmatic clefts well marked. Antennæ (fig. 9, *a*) of six segments of which the third is much the longest; formula, 3, (2, 6,) 1, (4, 5,).

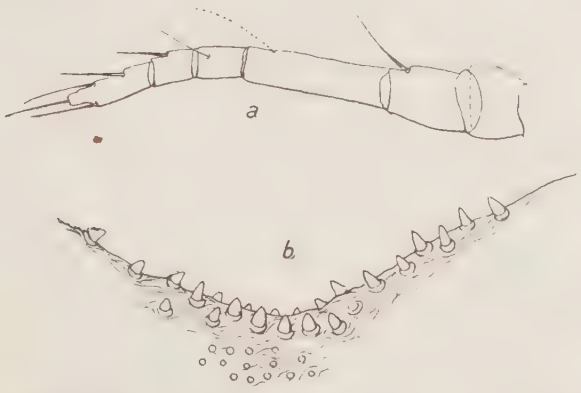

Fig. 9.—*Ceroplastes galeatus*, Newst.; *a*, antenna; *b*, stigmatic cleft, with spines.

Legs normal. Stigmatic spines (fig. 9, *b*) rather small, narrowly conical, and more or less uniform; they vary from 25–38 in number. Marginal spines simple, and rather short. Derm-cells ovate, rather large and widely separated, though most numerous just within the margin. Anal lobes minute. Caudal process obsolete.

Food-plant not stated. Entebbe, Uganda, 10. VIII. 1910 (*C. C. Gowdey*).

This insect belongs to that section of the genus *Ceroplastes* of which *C. floridensis*, Comst., may be taken as a type. The distinguishing feature of the test is the lateral extension of the wax, which is seen best when the insect

is removed from the branch: it then bears a very striking resemblance to a helmet in miniature; whether this character is a constant one remains to be seen, but as it is present in all of the examples before me, I feel that it cannot be due altogether to exigency of location upon the slender twigs. There are no dentate spines in the stigmatic clefts as in *C. floridensis* and the integument is uniformly chitinous in the old examples.

Ceroplastes vinsonioides, sp. n.

Test of old adult female.—Dusky crimson, or brownish with a faint tinge of dusky crimson: anterior margin sometimes paler (possibly pale crimson or pink when fresh): form rather broader than long; flattish above, with a central nucleus; sides slightly recurved and projecting, and radiating from them are four short, thick, elevated arms, the anterior pair sometimes deeply concave dorsally, and all of them may be tipped with white wax.

Test of young adult female.—Similar in colour to that of the older examples; flat, with central area slightly raised and nucleated: sides with four large and two small arms, the posterior pair shortest and tipped with greyish wax. Ventral surface (fig. 10, *a*) with a rather broad and conspicuously white line of secretion (wax) extending from each of the four stigmatic clefts to the tips of the radiating arms: the anterior half of the short posterior arms are also formed of pure white wax, but this rarely extends to the dorsal surface. Length of old examples, 4–5 mm.: width, 5–6 mm.; height, 1–1·50 mm.

Female, adult.—Cephalic region without a lobe-like extension: caudal process rudimentary: stigmatic clefts (fig. 10, *b*) sharply defined but not very deep; spines large, conical, and somewhat irregular in size, arranged three deep in the centre, suddenly merging into a double row and finally into a single one on either side; externally to these is a very large isolated and bluntly bidentate spine (fig. 10, *c*) separated from the group by a little more than its own length;

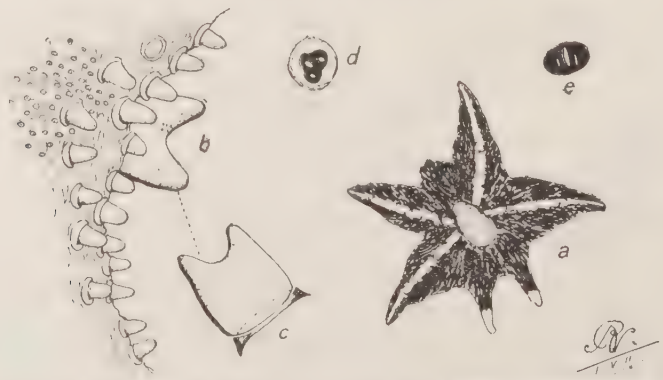

Fig. 10.–*Ceroplastes vinsonioides*, Newst.; *a*, young adult female, ventral view; *b*, stigmatic cleft, with spines; *c*, bidentate spine; *d*, *e*, glands.

parastigmatic glands numerous, forming a compact group just within the spines. Antennæ of 6–7 segments. Legs rather long; digitules very long, upper pair strongly dilated; claw minute. Mentum with several long slender spines. Apex

of anal lobes with three (possibly more) spines one of which (the most distal) is of great length; near the base of the lobes are several large spinnerets. Derm with innumerable spinnerets, those on the dorsum forming an indistinct elliptic zone; some of these (fig. 10, *d*,*e*) have two, others three orifices. Length, 2·25–2·75 mm.; width, 1·50–2 mm.

On Coffee: Namukekera, Entebbe, Uganda, 14. VIII. 1909 (*C. C. Gowdey*).

There were several adult females from this locality; and Mr. E. E. Green, to whom they were sent in the first instance, has retained part of the series. A single adult female was also found upon *Baikea eminii*, at Entebbe, 6. X. 1910 (*C. C. Gowdey*), but this individual was associated with, and completely surrounded by, a colony of the young forms and male puparia of a typical species of *Ceroplastes*.

The first examples submitted for examination were recorded in this Bulletin (Vol. I, p. 67). The star-shaped tests of the young adult females so closely resemble those of *Vinsonia* that I had at one time thought the insect referable to this genus; but having examined a longer series of specimens, including some old adults, I have come to the conclusion that it should be placed in *Ceroplastes*, for the following reasons:—(1) the test is formed of soft and easily soluble wax; (2) the ray-like extensions are not retained intact in the later stages; (3) the adult female is morphologically congeneric with *Ceroplastes*.

Ceroplastes africanus, Green.

On *Acacia* sp.; Khartoum, Anglo-Egyptian Sudan, 22. VI. 1910 (*H. H. King*).

This large species seems to be fairly common in Egypt, judging by the number of examples which have been submitted to me from time to time.

Ceroplastes rusci (Linn.).

On *Crataegus* sp.; Gizeh, Cairo, 31. VIII. 1910 (*F. C. Willcocks*).

The food-plant is new; but although this Coccid has been found upon several different kinds of plants, it occurs most abundantly on the cultivated fig, to which it is a very serious pest in parts of the Mediterranean area.

Ceroplastes quadrilineatus, Newstead.

One female only, on *Anona muricata*; Masaka, Uganda, 10. IV. 1909 (*C. C. Gowdey*).

Ceroplastes ? sp.

On Coffee; Uganda (*C. C. Gowdey*).

These are chiefly male puparia, with a few immature females. Not referable, I think, to *Ceroplastes vinsonioides*, as they are quite typical in form, and have too many lateral processes of white wax to agree in any measure with this species.

Ceroplastes ? sp.

On *Markhamia platycalyx*; Ndege, Uganda, 28. IV. 1910 (*C. C. Gowdey*).

As the waxy coverings of the specimens are all damaged and the female immature, it is impossible to determine the species.

Ceroplastes sp.

Male puparia only; possibly those of *C. quadrilineatus*, but as there were no females associated with them it is impossible to be definite on this point.

On *Anona muricata*; Masaka, Uganda, 10. IV. 1909 (*C. C. Gowdey*).

Ceroplastes sp.

Male puparia only.

Entebbe, Uganda, 3. III. 1910 (*C. C. Gowdey*).

Ceroplastes sp.

Male puparia only.

On Bark-cloth tree (*Ficus*); Bukoba, German East Africa, 4. IV. 1910 (*C. C. Gowdey*).

Inglisia conchiformis, Newstead.

On *Psidium guyava*; Entebbe, Uganda (*C. C. Gowdey*).

Ceroplastodes gowdeyi, sp. n.

Test of Female (fig. 11, *a*).—Opaque white, glassy: distinctly divided into relatively large, polygonal plates giving the test a coarsely reticulated appearance; form varying from short ovate to elongate ovate; dorsum flat; marginal series of plates sloping downwards; anterior third of ventral surface *enclosed* with similar plates to those forming the upper surface of the test, but apparently these are not continued beyond the area occupied by the female. The ventral surface of the dorsal plates is covered with densely felted wax. Length, averaging 4·50 mm.

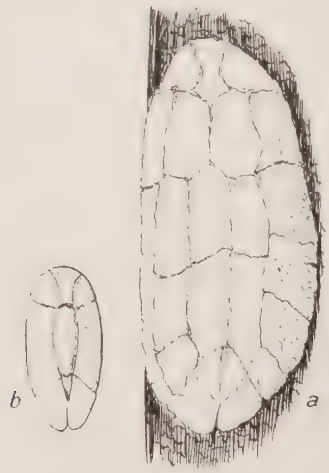

Fig. 11.—*Ceroplastodes gowdeyi*, Newst.; *a*, test or puparium of adult female; *b*, puparium of male.

Female, adult.—Lying freely within the test, but after gestation occupying the anterior portion only; the cavity behind the body being filled with empty skins of the ova and a little flocculent wax. Body shrivelled but distinctly Lecanoid in form; front slightly produced,

Female, old adult.—These were so completely enveloped by the hyphæ of a fungus as to render nearly all the structural details invisible. It was possible to ascertain, however, that the antennæ are similar to, or almost identical with, those in the young adult; the large dorsal pores are also present, though it is impossible to say if they are arranged in the same way; the marginal spines are identical; but the digitules of the anterior tarsi (fig. 12, *a*) are more distinctly dilated, and those of the claw are slightly less spathuliform.

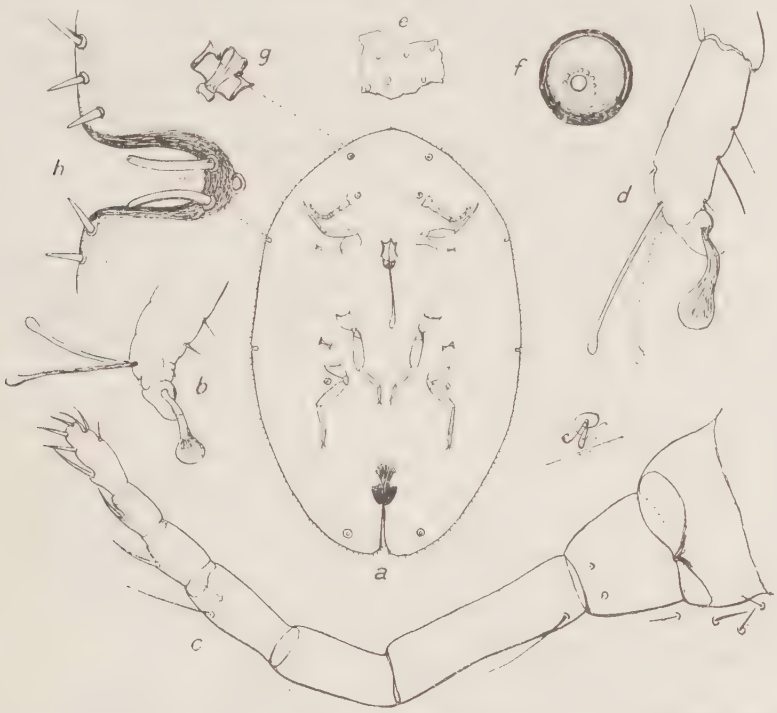

Fig. 12.—*Ceroplastodes gowdeyi*, Newst.; *a*, young adult female; *b*, tarsus of old adult female; *c*, antenna; *d*, tarsus; *e*, derm; *f*, one of the paired circular glands, ventral aspect; *g*, the same in profile; *h*, stigmatic cleft.

Female, young adult (fig. 12, *b*).—Ovoid. Anal cleft well defined; lobes longer than broad; setiferous ring with ten hairs. Antennæ (fig. 12, *c*) of eight segments; the sixth and seventh each with a single slender spine, the eighth with 4–5; there is a very long hair arising from near the base of the third and another from near the apex of the fifth. Legs well developed; ungues (fig. 12, *d*) very short and suddenly pointed; digitules broadly spathuliform; tarsal digitules very long and stout, but the apex is only slightly dilated. Stigmatic clefts (fig. 12, *h*) very deep and narrow; the two lateral spines long, stout and bluntly pointed; marginal spines short, simple. Derm (fig. 12, *e*) with small ovate pores, widely separated and faintly indicated. There are four pairs of circular glands (fig. 12, *f*, *g*), the first placed near the anterior margin; the second near the base of the antennæ; the third near the insertion of the second pair of legs; the fourth near the posterior margin, one on either side of the anal cleft.

Male puparium (fig. 11, *b*).—White, semiopaque and glassy. Form not differing materially from that of the genus *Lecanium*.

On African Bark-tree (*Ficus* sp.): Uganda Protectorate (*C. C. Gowdey*).

The examples were associated with *Lecanium nigrum*, Neitner, and being for the most part badly damaged or covered with "soot fungus" were mistaken, in the first instance, for the puparia of the *Lecanium*.

This very interesting insect is clearly distinct, and is, I think, rightly placed in *Ceroplastodes*: though the presence of large paired glands have not hitherto been observed in that genus. I have much pleasure in dedicating the species to Mr. C. C. Gowdey, who has done much to advance our knowledge of the Coccid fauna of Uganda during the last two years; and we sincerely trust that his researches in future may be rewarded by the discovery of many interesting forms of these and other insects.

Dactylopius longispinus, Targ.

On vine; Mehelleh-Moussa, Egypt, August, 1910 (*F. C. Willcocks*): found also on the "foliage of Mango trees imported from Ceylon," Horticultural Society's Garden, Gizeh, Egypt, 30. VIII. 1910 (*F. C. Willcocks*).

This common mealy bug is practically cosmopolitan, and attacks a large number of plants belonging to various Orders.

Tachardia decorella, Maskell.

On *Anona muricata*; Masaka, Uganda, 10. IV. 1909 (*C. C. Gowdey*).

This lac-producing Coccid is new to the African fauna, having been hitherto recorded only from Australia, India and China. Cockerell has described two species from Natal, *T. actinella* and *T. albida*, so that there are now three African representatives of the genus. The amount of lac secreted by *T. decorella* is not sufficient to be of any value from a commercial point of view.

Icerya longisetosa, Newstead.

On the branches of an undetermined shrub, near the north-western shore of Lake Nyasa, 30 miles south of Karonga, 4. VII. 1910 (*S. A. Neave*).

This insect was recently described from material collected by Prof. Vosseler, at Amani, German East Africa, on *Acacia* sp.

Aspidoproctus maximus, Sanders.

On an undetermined tree, at Fort Jameson, North Eastern Rhodesia, June, 1910 (*S. A. Neave*).

This is the so-called "Goliath Coccid," and is certainly the giant of its race, well-matured examples measuring as much as 33 mm. in length. It was discovered by Dr. Fulleborn in 1907 at Langenburg, German East Africa, and during recent years has become a pest in Rhodesia.

Lecaniodiaspis africana, sp. n.

Antonina (*?*) *africana*, Newstead (*sine descr.*), Quart. Journ. Liverpool Univ. I, 2, pp. 69, 72 (1906); Draper, Scale-Insects of Egypt, p. 11 (1907).

This insect may at least be considered as one of the minor pests of Egypt. All the material which has hitherto passed through my hands were immature females without ovisacs. In my private report to the Director of the Institute

of Tropical Research, Liverpool University, I referred the species doubtfully to the genus *Antonina*, and, at the time, gave it the provisional specific name *africana*. A copy of my report was also forwarded to Mr. Draper, the Delta Barrage Gardens, Cairo. Unfortunately the specific name was published (*sine descr.*) by the respective authorities inadvertently, and until now I have been unable to deal with the matter as the original material together with a number of other Egyptian Coccids was accidentally destroyed. Now, thanks to Mr. Willcocks, who has sent me a number of females in various stages, I have been able to make more extended observations and furnish details regarding the structural characters of the insect.

Female ovisac.—Very closely felted and almost wax-like in appearance. Cream-buff or straw-coloured, becoming greyer after long exposure. Form short ovate and very highly convex; posterior half with a faint trace of a short median ridge, but this is, in old examples, more or less broken up into a series of faint tubercular projections; on either side of the central ridge are a number of transverse ridges, varying in intensity according to the age of the individual, but in all cases they are interrupted centrally, and in old examples they are often represented merely by minute tubercular projections. Average length, 5 mm.; width, 3.50 mm.

Female, adult.—Very short ovate or sub-circular in outline, after maceration in potash. Antennæ (fig. 13, *a*) of seven or eight segments; sixth with one, eighth

Fig. 13.—*Lecaniodiaspis africana*, Newst.: *a*, antenna of female; *b*, leg of female; b_1, curious form of the trochanter, as seen in some individuals; *c*, mentum; *d*, spinneret.

with three rather straight and obtusely pointed spines; there is a slight variation in the relative length of the individual segments and also asymmetry. Legs (fig. 13, *b*) present but atrophied, length less than that of the antennæ; claws with a distinct ventral tooth. The whole of the dorsal surface of the derm is thickly and evenly studded with 8-shaped glands, all of uniform size and structure, but they are generally tilted so that the double orifice, which gives them the characteristic 8-shaped appearance, is rendered invisible. Anal segment with a rather shallow cleft which is closed ventrally, as in other members of the genus, with a large bilobed plate, each lobe being approximately triangular in outline, bearing a short stout spine at the apex and two or more near the base.

Anal ring with ten long stout hairs. There are 3–5 short spines of varying lengths at the margins of the anal cleft; but there are none at the margins of the body: there is, moreover, no trace of any stigmatic clefts or of the spines which usually accompany these structures. Derm, immediately opposite the base of the anal bilobed plate, with several spinose hairs, some of which are very long or equal in length to the longest axis of the plate. There are usually five cribriform circular plates arranged in two longitudinal and slightly divergent series. Length, 3.50–4 mm.

Female, young adult.—Dusky red-brown, brown or smoky brown, generally protected by a thin coating of grey or ochreous and somewhat granular secretion. Rather elongate and shaped somewhat like a *Lecanium*; dorsum with a very pronounced keel, at the base of which is a regular series of short transverse ridges, interrupted in the centre by a deep longitudinal groove. What the insect is like in life it is not possible to say; but it is quite evident that the transverse ridges which are so clearly indicated in the dried examples correspond with those found in the tests or ovisacs of the old adult females.

Male puparium.—Ochreous buff or pale straw-coloured, rarely creamy white; form normal: transverse segmentation or ridges generally distinct. Length, 1.50–2 mm.

On *Acacia arabica*: Ezbet el Nakhl, Egypt, November, 1909 (*F. C. Willcocks*); and on the same kind of tree in Upper Egypt, above Aswan, July, 1909 (*F. Hughes*): also on *Ficus* sp., near Cairo, summer, 1909 (*F. C. Willcocks*).

Lecaniodiaspis mimosae (Maskell) is, as far as I can gather, the only other African representative of the genus. This species was considered by Maskell* as only a variety of his *L. prospodidis*. Cockerell,† however, raised *mimosae* to specific rank, though he has not, to the best of my knowledge, stated his reasons for doing so. Recently I had thought that *L. africana* might be specifically identical with Maskell's *mimosae*; but Maskell (*loc. cit.*) distinctly states that the "feet" are absent in his *L. prospodidis*, and that as far as he could see "there is nothing but size and colour" to distinguish his var. *mimosæ* from it. I have come to the conclusion, therefore, that as *L. africana* possesses relatively well developed legs it cannot be referable to either of Maskell's species.

Tachardia longisetosa, sp. n.

Test of adult female.—Smoky ochreous buff to dusky amber-yellow. Isolated examples are distinctly hemispherical in form, with strong and somewhat wavy ridges radiating from the dorsum. Central orifice distinct and surrounded by a dull crimson area. Diameter, 3–5 mm.

Female, adult.—Ovoid in outline, after maceration in potash. Antennæ absent. "Lac tubes" very short and much more transparent than in *T. decorella*, Mask.; sub-central group of pores compact; outside the central compound group are several (17–20) circular pores irregularly scattered over the broader portion of the structure; surface evidently reticulated. Anal spine distinctly funnel-shaped. Anal process prominent; anal ring with ten very long hairs projecting considerably beyond the pointed dorsal process (? modified anal lobes); the latter

* Trans. N. Zealand Inst., 1896, p. 316.
† Check List, Supp. p. 392 (1899).

with distinct serrations at or near the base of the dorsal edge. The individual glands forming the compound marginal groups, circular; central orifice escutcheon-like: periphery with from 2–4 clear, bead-like processes: when two of the latter are present they are arranged on opposite sides: when there are three they form a triangle, and when four in number they are equilaterally placed. Length (average), 4 mm.

On *Ficus* sp. (Bark-cloth tree): Entebbe, Uganda, 16. III. 1911 (*C. C. Gowdey*).

The tests of this species bear a very strong resemblance to those of *T. decorella*, Mask., but they are generally larger and less regular in form. The female differs from the latter in the great length of the hairs of the anal ring; and from *T. actinella*, Cockerell, in the absence of antennæ.

A large percentage of the insects are infested with Chalcidids.

Aonidia glandulosa, sp. n.

Aonidia glandulosa, Newstead, Draper (*sine descr.*), Scale-Insects of Egypt, p. 11 (1907).

Female puparium.—Straw-coloured or ochreous buff with faint patches of dull orange-yellow: highly convex, sometimes obconical, with the highest portion towards the anterior margin; margins thin and sometimes rounded; larval pellicle yellow, generally completely hidden; second pellicle invariably covered with secretion. Ventral surface white, with an external zone of pale yellowish white; second pellicle large, bright orange-yellow, nude. Ventral scale white; circular: thick at the margins, thin and semi-transparent centrally. Diameter, 1.25 mm.

Fig. 14.—*Aonidia glandulosa*, Newst.: *a*, adult female: *b*, margin of pygidium: *c*, nymphal (second stage) female.

Female, adult (fig. 14, *a*).—With the cephalic segment strongly defined and distinctly articulated, anterior margin very broadly rounded. Rudimentary antennæ with a simple spine. Parastigmatic glands 5–6 in number, large; just

in advance of these are two slender hairs; there is a similar hair near the antennæ and usually four marginal ones. Thoracic segments with several (4-6) slender spinose hairs. Pygidium very broadly rounded the central area of the dorsal surface with innumerable clear granular spaces (? glands) rendering the integument strikingly characteristic; dorsal pores in three well-defined series; margin (fig. 14, *b*) distinctly crenulated and thickened; median lobes widely separated and divergent; second pair small; third rudimentary; there are 2–3 rudimentary squames between the second and third lobes and 5-6 long slender spines beyond them. Vaginal orifice near the base of the pygidium. Anal orifice just within the margin; this organ is partly closed by a pair of valve-like processes.

Female, nymph (fig. 14, *c*).—Integument strongly chitinised. Cephalic segment much more constricted than in the adult insect, the articulation is also much more pronounced, and just within the anterior margin is a pair of large clear ovoid spaces (? glandular) which stand out in marked contrast with the surrounding tissues. Pygidium similar to that of the adult, but the median lobes are close together, the margin is more strongly crenulated, and the clear "granular" spaces on the dorsal area are less conspicuous owing to the opacity of the integument.

On "Sunt" tree (*Acacia arabica*); Upper Egypt, above Aswan, July, 1909 (*F. Hughes*). The specimens recorded by Mr. Draper (*loc. cit.*) were also found on *Acacia arabica*, in Egypt.

As the nymphal females are much more easily prepared for microscopical examination than the adults, the pair of large cephalic (?) glands will serve at once to distinguish this insect from its allies; and both stages may be recognised by the curious appearance of the pygidium.

Sphærococcus marlatti (Cockerell).

Phœnicoccus marlatti, Cockerell, Pr. Ac. N. Sci. Ph., p. 262 (1899).

Sphærococcus draperi, Newstead, Quart Jour. Liverpool Univ. I., 2, p. 70 (1906); Draper, Scale-Insects of Egypt, p. 12 (1907).

Having re-examined my material, I have come to the conclusion that the insect which I recorded (*loc. cit.*) is specifically identical with Cockerell's *Phœnicoccus marlatti*, and as the latter was described in 1899, the name *draperi* must sink as a synonym. I do not agree with Cockerell, however, that this insect should be separated from *Sphærococcus*, Maskell, simply because the antennæ are "reduced to a mere tubercle." All the characters are really conformable to the genus and as regards the antennæ Maskell* distinctly states that these organs are "sometimes atrophied." I am convinced therefore that *Phœnicoccus*, as a genus, cannot stand. Cockerell's types were found in America on date palms (*Phœnix sp.*) imported from Algeria. Draper (*loc. cit.*) says that these insects locate themselves at the base of the leaf stalks which they completely cover with the white flocculent or felted matter. He states also that "the pest can be destroyed by painting with strong kerosine emulsion which should reach all infested parts" and further that it is very common in Lower Egypt.

* Trans. N. Zealand Inst. V. XXV., p. 237 (1892).

ON A NEW GENUS OF PSYLLIDÆ FROM NYASALAND.

By Robert Newstead, M.Sc., A.L.S., &c.

The remarkable insect herein described belongs to the family Psyllidæ, of which relatively few species have hitherto been recorded from Africa. The pupæ (and possibly also the larvæ) cover themselves with dense masses of white flocculent or wool-like wax, the separate strands of which are sometimes over one inch in length. These flocculent coverings are arranged together in large patches on both the leaves and stems of the food-plant so that they are thereby rendered most conspicuous. The habit of secreting coverings of white wax is common to many members of this family of the Homoptera; but the great length to which it attains in this species is quite exceptional and noteworthy.

Pseudoeriopsylla, gen. n.

Female:—Head with the frons twice as broad as long, front indentate or slightly cleft; eyes hemispherical, prominent. Thorax with the pronotum equal in width to the frons, convex. Wings (fig. 13) broadly lanceolate, with a large stigma; stem of sub-costal vein nearly as long as the upper branch of the cubitus; radius of sub-costa short, and from it arises a very short supernumerary vein which merges into the costa near the middle.

Pseudoeriopsylla nyasæ, sp. n.

Female.—Colour of dried specimens pale ochreous buff; mesothorax with two bilateral, elongated and curved blotches of pale brown. Venter of abdomen covered with dense creamy white plates of wax. Antennæ fulvous, tips infuscated. Eyes black, with a faint margin of pale crimson. Legs ochreous buff; tibial spines jet-black. Wings (elytra) (fig. 13) hyaline, broadly lanceolate, costa

Fig. 1.—*Pseudoeriopsylla nyasæ*, Newst.; wing (elytron) of female.

more distinctly arched than the hind margin; stigma large, upper portions of the periphery black or infuscated; stem of sub-costa infuscated just below its junction with the cubitus; there is also a large infuscated area or blackish spot on the margin immediately behind the lower fork of the cubitus; the tips of the succeeding veins on the hind margin are also infuscated and there are

three triangular spots alternating and equidistant between them, formed by groups of dark coloured spines. Length of *dried specimen*, 3·50 mm.; length of wing, 5 mm.

Pupa.—Ochreous buff to ochreous brown (dried examples). Antennæ of three segments, of which the third is much the longest: all the segments with many fine hairs some of which are long, others very short, and there are two slender spines at the tip of the terminal segment. Legs stout and setose. Wing-sheaths with a fringe of rather long slender bristles and slender spines arranged more or less alternately. Abdomen short and broadly rounded posteriorly, margin with a fringe of fine bristles or hairs; derm with large tracts of minute circular spinnerets, and with narrow bands of minute spines arranged transversely.

Secretionary covering of larva.—Pure white, composed basally of dense flocculent matter, externally of very long wool-like filaments varying in length from 6 to 26 mm.

Eggs.—Pale yellowish, when empty pearly white. They are laid upon the surface of the leaves and are protected with a layer of white and rather densely felted wax, the latter extending beyond the eggs for some considerable distance.

On the leaves and small branches of a species of fig (local name "Kachire"); near the north-west shore of Lake Nyasa, 4. VII. 1910 (*S. A. Neave*).

April 18th, 1911.

ON THE GENITAL ARMATURE OF THE MALES OF GLOSSINA MEDICORUM, AUSTEN, AND GLOSSINA TABANIFORMIS, WESTWOOD.

By Robert Newstead, M.Sc., A.L.S., &c.

Since the publication of my paper dealing with the taxonomic characters of the genital armature of the males of all the then known species of tsetse-flies* Mr. E. E. Austen has very kindly allowed me to examine a paratype of his *Glossina medicorum*; and Mr. Guy A. K. Marshall, on behalf of the Entomological Research Committee (Tropical Africa), has submitted to me the specimen of *G. tabaniformis*, Westwood, upon which Mr. Austen based his re-description† of the male of this species. I am extremely indebted to these gentlemen for giving me the opportunity of making a microscopical examination of these insects, as thereby it has enabled me to complete my observations on the male armature of the tsetse-flies, and also to complete the set of drawings illustrative of the main morphological characters of these organs.

The examination has revealed the fact that the superior claspers (*sc* in both figures) are free as in other members of the "*fusca* group" (Newstead, *l.c.*) but in other respects, especially in the form of the harpes, they are markedly distinct; and these organs alone will serve as a ready means of identification: those of *G. tabaniformis*, being unusually complex, while those of *G. medicorum* are extremely simple. Apart from the structural character of the armature of the males, both sexes in *G. medicorum* may be distinguished by the shortness of the lateral branches of the hairs of the arista.

I do not propose in this communication to place these tsetse-flies in their relative positions in the synopsis which has already been published in the Bulletin, as, since the publication of Mr. Austen's most excellent "Handbook of the Tsetse-flies," this is quite unnecessary.

I may here add, in connection with this subject, that I have recently examined a single male *Glossina palpalis*, which was captured by Dr. Allan Kinghorn in N.E. Rhodesia, and have found that the superior claspers of this specimen are not specifically identical with those found in the Gambia and elsewhere on the West Coast of Africa. As the microscopical preparation of the armature is not in a perfect state of preservation, I cannot yet add any further particulars: but as far as I can judge at present, I believe it to be representative of a distinct race.

* Bull. Ent. Res., Vol. II., p. 9, 1911.

† Handbook of the Tsetse-flies, p. 83, 1911.

Glossina tabaniformis, Westwood.

This tsetse-fly bears a very striking external resemblance to *Glossina medicorum*, Austen, but is separable from the latter by its slightly longer palpi; by the characters of the armature of the male; and the greater length of the lateral branches of the hairs on the arista. The exact specific differences between these two species are set forth in the following table:—

	tabaniformis.	*medicorum.*
Lateral branches of the hairs of the arista.	Very long, the terminal one about one half the length of the free end (tip) of shaft.	Very short, the terminal one about one fifth the length of the free end of the shaft.
Harpe of male.	With four narrow, pointed appendages.	With one broadly lanceolate appendage.

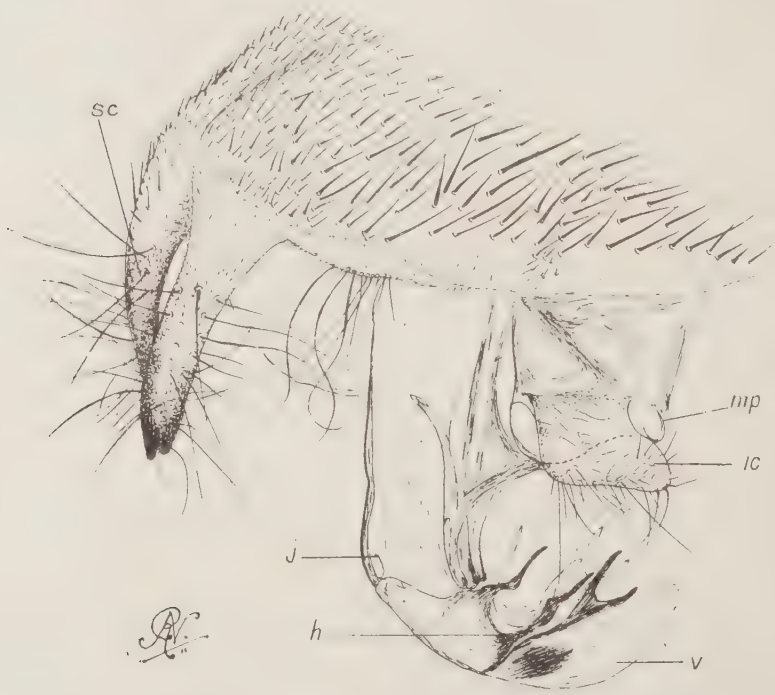

Fig. 1.—Male armature of *Glossina tabaniformis*, Westwood; lateral view.

Genital armature of the male (fig. 1).—Superior claspers (*sc*) free, of almost uniform width throughout; apices bluntly and asymmetrically bidentate; bristles very long. Inferior claspers (*ic*) very broad and rather short; a few of the hairs at the margin rather long, the rest short. Median process not reaching the distal

margin of the inferior claspers, but projecting laterally beyond the claspers on both sides. Sclerites of the juxta or penis-sheath (*j*) branched near the anterior third. Harpes divided into four pointed processes, the basal pair being widely separated and attached to a semi-circular and narrow sclerite; the distal pair are united to a solid and somewhat rectangular process, the stem of which is attached to the semi-circular sclerite which supports the first pair of pointed appendages; collectively these appendages are distinctly antler-like and strikingly characteristic.

The above description has been drawn up from an examination of three males as follows:—The example from which Mr. Austen drew up his description, taken at Oban, Southern Nigeria, in August, 1910 (*J. H. J. Farquhar*). One taken at Atta-Kwama Akapim, Densu River, Gold Coast; the third from Agbabu, Ondo District, S. Nigeria, 12. VI. 1909 (*Dr. Hannington*), both in the collection of the Liverpool School of Tropical Medicine.

Glossina medicorum, Austen.

Genital armature of the male (fig. 2).—Superior claspers (*sc*) free, bluntly bidentate (as seen in profile) and furnished with the usual long hairs. Editum (*e*) with very few long hairs. Juxta (*j*) relatively longer than in the other members

Fig. 2.—Male armature of *Glossina medicorum*, Austen; lateral view.

of this group; the middle of the anterior margin with a large projecting sclerite which rests or impinges upon the median process, being similar to that in *G. tabaniformis* but much more attenuated. Harpes (*h*) simple and broadly

lanceolate, apices distinctly thickened ; immediately below these organs is a large dark chitinous patch, the outer portion of which is broken up into more or less isolated but minute fragments ; median process (*mp*) very short and not extending to the margin of the inferior claspers, being visible only at the base of the latter. Inferior claspers (*ic*) markedly produced anteriorly.

The only male which I have so far been able to examine bore the following data :—" *Glossina medicorum*, Austen. Paratype. E. E. A. 8. III. 1911. Sanguin R., Liberia, W. Africa, 27. XI. 1908. Surg. A. McCloy, R.N., 1909–1."

20th May, 1911.

NOTES ON THE HABITS OF BLOOD-SUCKING FLIES OBSERVED IN DOWA DISTRICT, NYASALAND.

By Dr. Meredith Sanderson,
Medical Officer, Nyasaland Protectorate.

Hæmatopota vittata, Loew.

This species is not common. It is found mostly in native gardens or in gardens now fallow, preferring maize or long grass. It differs from other species in that it does not bite quickly, but "settles" itself first, as though to get a comfortable position for the legs, etc.; also in that it bites with its wings extended. *H. vittata* is very quick on the wing and is difficult to capture. It seems more prevalent on dull days, and was not found till the rains had well set in and the herbage was some feet high.

Hæmatopota pertinens, Aust.

Found mostly on stony ground and small hills. It occurs occasionally in houses and in villages, but seems to prefer uncultivated, barren ground. Especially prevalent on dull showery days, but was found during the period immediately antecedent to the rains. Easy to catch with the hand. Bites immediately on settling, and causes considerable annoyance by mere numbers.

Hæmatopota mactans, Aust.

Found mostly in association with large trees and grass. It has a noticeable habit of moving the abdomen rapidly when biting, and of moving its legs on settling, like an animal eager for its food. Not easy to catch.

No species of *Hæmatopota* has been found to bite in early morning or after sunset.

Tabanus ditæniatus, Macq.

Always found in sunlight on the Lake-shore (sandy) or in sandy river-beds, especially of small streams.

Tabanus unitæniatus, Ric.

Habits similar to those of the preceding species. Both these insects enter and remain in houses. The males are common.

Tabanus tæniola, P. de B. var. **variatus,** Walk.

This species is noisy on the wing and advertises its presence by flying about and "banging" itself against some object in settling. Found on the Lake-shore, and for some distance on the Lake itself, having been caught over a mile from the shore, in a canoe. Inland, it is most prevalent on the foot-hills, near small streams. Here

it occurs in large numbers and enters a tent or house freely. The bites are painful, but rare, owing to the noisy habits of the insect. Can be felt to settle and frequently walks about before biting, especially on clothes.

Tabanus africanus, Gray.

Found in thick bush or in "Matete" reeds on the Lake-shore or along rivers, never occurring in large numbers. It bites quickly when it settles, but flies about in a characteristic fashion before settling, *i.e.*, it flies *past* one very quickly —never *round* one. Difficult to catch.

Tabanus biguttatus, Wied.

Found always near running water, only during heat of the day. Rests on trunks of large trees. Bite severe and causes bleeding.

Glossina morsitans, Westw.

There has been a very striking diminution in the number of this species since the onset of the rains. Places where the fly caused great annoyance at the end of November (and during the dry season) are now, to a casual observer, free from it, and only a few specimens can be found after careful search. This fly is now found in greatest numbers in association with large trees—that is to say, in bush which has never been cultivated—preferably in conjunction with a sandy soil. In such localities the fly is found in as great numbers as formerly, and they bite as freely.

G. morsitans has been observed to settle, during the hours from 12 to 3, on the sand of small streams preferably where it is dry, but they have also been seen on wet sand, though not for any length of time. I have never seen them go near actual water.

I have not noticed any disinclination to bite when their victim is stationary, as noted by some. Though they do accompany one when walking or cycling, they seem to me to bite more when one is standing or sitting still. This is based on six months' observation, living in the fly-belt.

There are two localities (connected by a narrow belt) where the fly is thickest in this neighbourhood, and there is a striking coincidence between this distribution and the occurrence of cases of human trypanosomiasis: of a total of 14 cases, only one cannot definitely be traced to have been infected in this locality.

As regards the spread of the fly, I can say nothing from personal experience. I have very definite statements from a resident of 17 years standing that the fly has extended from a small area near Rifu to the present wide-spread area, during 8–12 years. His estate was then free from fly, but is now infested with it. Similar statements are made by various members of the Dutch Mission. The occurrence of game certainly coincides with the limitation of the "fly-belt," but so also does "cover," *i.e.*, bush. Both fly and game shun the denuded slopes of the higher foot-hills.

February, 1911.

THE RELATION BETWEEN GAME AND TSETSE-FLIES.

By Major J. Stevenson Hamilton,

Warden, Transvaal Government Game Reserves.

The theory that the larger wild mammals, commonly called "big game," are solely and entirely responsible for the presence of tsetse-flies, has become so firmly fixed in the mind of the average "man in the street" in South Africa, that no amount of contrary argument or even proof, were such forthcoming, could ever have much effect in altering his opinion. The newcomer quickly assimilates the same idea, and after a time begins to voice it as assertively as his mentor. It is thus most difficult to obtain really reliable data. An investigator, beginning an enquiry with an open mind, finds himself flooded with such a mass of apparently well substantiated statements, provided by experienced and obviously sincere persons, that he can with difficulty keep his mind free from a certain amount of bias. Starting from the assumption that the presence of fly depends upon that of game, arguments against the continued existence of the latter quickly multiply in the public mind. I was talking to a friend the other day, and he mentioned that he had been replying to some questions upon this very subject. He was no partisan of the anti-game movement, but regretfully expressed his conviction that in order to get rid of tsetse-fly it would be necessary to abolish the larger animals. I ventured to ask for some clear instance of this interdependence. He was unable to quote any first-hand evidence which might not have been explained away, and his main contention, in short, was, "Of course the fly is dependent upon the game, everyone with any experience knows that: ask any old hunter or native." This, I think, about sums up the ideas of the majority of people, and, if further argument is deemed necessary, the assumed general disappearance of the fly after rinderpest is pointed to as affording conclusive proof. The presumption is, of course, that the fly, deprived of its means of subsistence, died of starvation. An acquaintance with some of the districts visited by the epidemic would however by no means indicate that this was the real cause of the phenomenon, where it occurred. A study of the effect of rinderpest upon the relations between fly and game, might indeed, were it possible always to obtain accurate data, shed some new and interesting light upon the whole subject.

The rinderpest, like many epidemics, pursued its course in a rather erratic manner. Here a range of mountains diverted it, there it swept down one bank of a river and left the other untouched. Sometimes a comparatively large area was entirely unvisited, while all the surrounding country was ravaged. The Barotse Valley, wherein many thousand head of cattle were located at the time of the visitation, was absolutely unaffected, though many of the neighbouring areas were denuded of stock. The wild animals which suffered most severely, after buffalo, were the tragelaphines—eland, kudu, and bushbuck—but reedbuck, duiker, and in fact all the horned ruminants possessing a large moist rhinarium, also paid heavy toll. Sable and roan antelope, wildebeest, impala, and others

possessing a partially hairy rhinarium, appear to have been much less affected. Warthog and bush-pigs died in large numbers at the time of the disease.

Before the epidemic, tsetse-fly of one kind or another occupied many of the areas in South and Central Africa, which were also the haunts of such large bush-loving animals as, for example, buffalo and kudu. Hunters and travellers passing through, but seldom remaining long in the districts, very naturally associated such species with the fly. The apparent absence of both from the same area at a later date, was further held to prove the connection; though temporary migration of the one, and fluctuation of the other, due to climatic causes, may conceivably have been nearer the truth. Most of these hunters and travellers too, believed that fly depended upon game, especially upon buffalo, and they tried to make everything they saw fit in with this preconceived idea.

The rinderpest seems to have exercised some obscure influence upon at least certain species of tsetse-flies in a good many places. While there is no doubt that *Glossina morsitans* (?) absolutely disappeared from considerable areas during the course of, or immediately after, the epidemic, we have it on reliable authority that elsewhere it was in no way affected. Facile as may be the explanation that the disappearance of the insects, where it occurred, followed in natural course the disappearance of the game, it can hardly be said to be borne out by facts. Only the BOVINAE and those antelopes most closely approximating to them were greatly affected, while many species were practically untouched. Impala, for instance, which were very numerous throughout the old fly-areas in the eastern Transvaal, seem to have suffered hardly at all. Therefore the matter is reduced to a question of whether the fly ceased to exist because of the practical extinction of the animals which suffered most from rinderpest—buffalo, kudu, eland, and bushbuck.

The north-eastern Transvaal being a comparatively small area, and being one moreover of whose history past and present, nine years residence entitles me to speak with some authority, will furnish a convenient instance of what may have taken place elsewhere. All the four species of animals indicated above abounded —say thirty years ago—through the greater part of the country between the Olifants and Crocodile Rivers, an area of about 120 miles by 60. There were also three distinct belts of fly between these two rivers. I am obliged, here and elsewhere, when speaking of pre-rinderpest days, to use the ambiguous term "fly" when referring to *Glossina*, because there exists no record as to what the particular species was. From the nature of the country, and the reputed character of the insect, it may however be assumed that either *G. morsitans* or *G. pallidipes* was present. The fly is spoken of as having been very pertinacious and aggressive, attacking men, and the donkeys which hunters occasionally brought into the areas, most savagely. Donkeys always died subsequently, the described symptoms being those of nagana. Although the old hunters, Dutch and British, were far from being entomologists, they nevertheless all knew the general appearance of a tsetse-fly. TABANIDAE and *Stomoxys* are still present, but it is inconceivable that they could have been mistaken for tsetses.

By 1896, uninterrupted and wholesale shooting by white hunters and natives, extending over a long term of years, had nearly exterminated the eland, and had

reduced the buffalo to two herds, probably together not reaching a couple of hundred individuals. During all this time there seems to have been no perceptible general diminution of the fly, though it undoubtedly fluctuated, disappearing without apparent cause from some parts of its range, and reappearing in others.

It certainly existed in very large numbers right up to the outbreak of rinderpest, and in one of the areas buffalo had long ceased to exist, though other kinds of game, especially waterbuck, sable antelope and wildebeest, were numerous. During the early stages of the rinderpest, that is during the cold weather of 1896 (the disease having been most likely introduced into the game country by the cattle of the farmers coming for the winter grazing), fly was observed to be present on the Sabi some miles below my present station. The game was dying fast about October, when the fear of fever induced the usual abandonment of the low country by Europeans. In the following December, that is to say in the height of the hot weather, a low country resident, Mr. Ingle, visited the Sabi (where fly had been observed in the previous June), and was surprised to find none present. When early in the following healthy season the High Veld hunters arrived once more, it soon became apparent that the fly had wholly or nearly disappeared from all the low country, having apparently done so between October, 1896, and June, 1897. Since the latter year there has been no tsetse reported in the Transvaal. That it has really gone is shown clearly, in other parts, by the immunity with which domestic animals can be taken into any part of the country, while in the district of which I am speaking, I have myself lived since 1902 in the middle of one of the old fly-areas, with cattle, horses and donkeys, and have probably, at various times, marched through and camped in nearly every square mile of the country with my transport. Moreover the five white rangers employed by Government, all stationed at different points within the district, have been similarly employed at all seasons of the year in pursuance of their duties. We have never lost a single animal or seen a fly, and the local natives now keep stock where formerly it was impossible. I think it may reasonably be concluded therefore, so far as it is possible to speak of anything with certainty, that no species of *Glossina* now exists in the eastern Transvaal. The bare rocky hills of the Lebombo Range separate this low country from Portuguese territory, and the investigations of the Entomological Department at Lourenço Marquez have not shown the presence of any kind of tsetse-fly in the southern part of the Province adjoining the Transvaal, though it formerly existed there in great numbers. Cattle are also kept by natives on both sides of the border. This, I think, precludes the possibility of fly having migrated from the Transvaal into the southern part of Mozambique.

After the rinderpest, it was found that the last of the eland in the North-East Transvaal had disappeared, and that the buffalo were reduced to a herd of about twenty, which remained in the densest part of the Sabi Bush—the heart of the former fly country. A small number of kudu and bushbuck survived in the same locality. Impala, wildebeest and other species, native to the district, appeared much as formerly.

It seems to be the case that from some hitherto unexplained cause, tsetse-fly, in the north-eastern Transvaal, became quite extinct during the rinderpest. This

result can scarcely have been due to the reduction of its food supply. In the absence of any other destructive cause, the fact that even a few buffalo, kudu, and bushbuck survived, supposing these animals to provide the favourite food of the insects, must surely have induced at least a partial survival of the latter, a nucleus which in the course of years, would have increased with the increasing herds. The buffalo had, for a long time, been so continuously hunted and persecuted, that they had become accustomed to adhere very rigidly to the large extent of dense thorn bush, which coincided with the fly-belts, and seldom if ever left it. This Sabi bush consists of very closely growing acacias (*A. spirocarpoides*, *A. arabica* var. *kraussiana*, &c., &c.) ; there is very little undergrowth, and, though there are numerous small watercourses intersecting the country, they are all dry sand-beds during the greater part of the year, and the only permanent water is the Sabi River, to within 50 yards of which the bush grows. The soil is shallow granite sand, imposed on a substratum of more or less solid rock. The height varies from 500 to 1,000 feet above sea-level, and the mean night and day shade temperature throughout the year is about 72° Fahr., with an average rainfall during the last few years of about 20 inches. The latitude is 25° 15′ S.

Seeing that the various fly-zones in the Sabi district, all very similar in nature, ran more or less in parallel directions, and at no great distance apart, it appears improbable that all the numerous animals which survived the rinderpest, or that even the buffalo alone, would have prolonged their absence from one or the other for so long as to account for the death of all the flies from starvation, supposing this to be the logical outcome thereof. At present there are living within the old fly-areas several herds of buffalo of considerable size, together with a very large number of kudu, bushbuck, impala, waterbuck, duiker, wildebeest, zebra and sable antelope, and I have personally spent a great deal of time camping about there with my transport animals, in order to observe the progressive increase of the buffalo.

Here then, seems to be a clear case of fly having from some cause become extinct, although game of all kinds continued to exist in the areas formerly occupied by it.

I have also had a personal experience of the existence of *G. morsitans* in large numbers where there was little or no sign of the larger mammals.

In 1908 I travelled through the northern part of Portuguese East Africa from Ibo on the coast to Lake Nyasa, roughly along the 13th parallel of latitude. Tsetse-fly was met with in two places ; first, in a small belt near the Mwagidi River, not far from the coast, and secondly, from the right bank of the Msalu to the right bank of the Lujenda River—a distance of about 80 miles, as the crow flies. No signs of any game were found until we had passed through the first fly-area ; then, in one place, we came on a very few kudu, and in another, saw a single waterbuck. In the fly-areas themselves there was no indication of the presence of big game, nor indeed of that of any of the lesser species of buck. Hares were pretty numerous, monkeys not uncommon. The forest was full of small birds, and judging by their "runs," smaller mammals probably abounded. Throughout the larger area, fly was practically continuous, and though it was then the coolest season of the year, was extremely troublesome, often biting

ourselves and our natives after sundown. I collected several of the flies from each belt, and handed them over to the Entomological Department at Lourenço Marquez, where Mr. C. W. Howard ultimately pronounced them to be *Glossina morsitans*.

Now as regards the almost complete absence of game. Since it was the driest time of the year, and the Msalu and Lujenda are both of them perennial streams, one would have expected to find indications of game in their vicinity, if anywhere. But though my companion, Mr. R. C. F. Maugham and myself, having a large number of carriers to feed, hunted assiduously in the most likely spots on every possible occasion, we were entirely unsuccessful in finding even old tracks dating from the last rains. Although game often temporarily migrates from a country, I scarcely think it could ever have been very numerous along the route we took. The character of the vegetation was not such as finds most favour with antelopes generally, and during our constant examinations of the sand-beds of the dry watercourses, I do not think it would have been possible to help noticing indications of the recent presence of wild animals in any numbers. Nor, in view of the fact that nearly every adult native we met was in possession of firearms of some description, did there appear any particular reason for doubting their statement that they had shot out most of such game as had existed in the country, long before. Certainly the swarms of *G. morsitans* which we encountered must have been hard pressed by hunger if forced to depend for their existence upon the blood of a few stray herds of the larger species which may have existed. It was noticeable that the fly was most in evidence near the camping and halting places. The route which we followed is the usual one from the interior. It is, in fact, the old slave caravan road, and at the present time, or at least three years ago, natives were accustomed to make use of it only in very large parties, owing to their fear of the predatory bands of the independent Yao chiefs, which were always on the look out to snap up solitary travellers and small detachments. The fly-belts themselves are thinly populated, and the natives kept no stock except a few rather anæmic-looking goats. The fly was not much in evidence in the clearings round the villages.

In the fly-areas, as in all the country we passed through, the vegetation was remarkable for the total absence of thorn acacias. Except near the watercourses it was stunted, and the trees included such forms as *Brachystegia pectinata*, *Rhus longifolia*, *Eugenia guineensis*, *Combretum microphyllum*, and *Afzelia*. There was a good deal of long thick grass, and in places, much dense undergrowth. I think the fly was always thickest about the dry stream beds. These were the ordinary caravan halting places, water being obtained in occasional small pools or by digging. I saw a lot of fly at one halting place where a narrow swampy stream trickled through mud and long grass. Dry bush, in this and every other case, grew near at hand. A few stray flies only were noticed on the right bank of the Msalu River, but as soon as we crossed we had practical proof of their presence in large numbers, and this continued through nearly all the bush country to about two miles from the Lujenda, where cultivation seemed to stop them quite suddenly. A Portuguese officer said that in places they came quite close down to the Lujenda, where there was bush and no cultivation.

The temperature at that time of year (July and August) varied between a maximum of 85° Fahr. by day, and a minimum of 50° Fahr. by night. There was no rain. The soil showed a fairly constant formation of metamorphic granite rock, traversed by quartz reefs; there were no apparent indications of clay, slate, or limestone. The surface of the ground was generally covered with granite sand. The mean altitude of the plateau where the fly was found was about 1,500 feet. Judging from the vegetation, I should think there was a fair, though not an excessive, rainfall in the wet season.

As soon as we crossed the Lujenda, a wide and deep river, we got quite out of touch with the fly. The land gradually rose from 1,800 to about 2,500 feet at the base of the Nyasa Mountains. This piece of country was very much better watered than the dry plateau between the Msalu and Lujenda Rivers, and there were traces (albeit scanty ones) of buffalo, elephant and hartebeest. Up to 3,000 feet there seemed little change either in the vegetation or in the nature of the soil, but *Glossina* were entirely absent, so far as we were able to judge, along our route west of the Lujenda.

Although it would be rash to express any dogmatic opinion concerning so complicated a matter as the relation between tsetse-fly and game from the experiences of a journey embracing only one period of the year, I feel fairly convinced that within the above area the fly, *G. morsitans*, exists to a great extent independently of the blood of large quadrupeds. I am further induced to believe in the general absence of the latter from the fact that from first to last I did not see a grass tick of any kind. These insects are, I think, nearly always found in tropical countries, where many large mammals wild or tame exist, and moreover, being able to live for many months without blood, are independent of occasional temporary migrations of wild animals from their vicinity. It was of course winter, but the temperature during our journey was never so low as to have impaired their vitality had they been present.

Komati Poort, March, 1911.

DESCRIPTION OF HAUNTS OF GLOSSINA TACHINOIDES IN BORNU PROVINCE, NORTHERN NIGERIA.

By Dr. B. Moiser,
West African Medical Staff.

During conversation with the Resident of Bornu Province, Northern Nigeria, I learned that a former Medical Officer of the district had discovered, some six or seven years ago, a tsetse-fly belt near Mulgue, about 40 miles south of Maifoni, Bornu, and I therefore decided to investigate the locality in July, 1910.

On my way there from Maifoni, while camping at Mulgue, I found that the natives are well aware of the presence of the flies in their district, and know that they kill horses and cattle, so that they take good care not to allow these animals in the district at all.

I was told that the flies can be seen all the year round, but that they are more numerous during the rainy season. The rains start about May, only a little falling during that month and June, but during July, August and September rain is fairly frequent, the total fall measuring about 30 in. Rain usually falls in short, sharp showers, seldom lasting longer than a couple of hours. During the rainy season, the average daily maximum shade temperature is about 90° to 95° F., while in March and April, which are the hottest months of the year, the maximum temperature is about 115° F. The minimum varies from 50° to 70° F.

I had with me some horses, and was told that I could safely take them as far as a village called Pyem. I was also escorted by the headman and two followers, all of whom were mounted, and we rode together through the fields of young guinea-corn and ground-nuts to Pyem, were we dismounted. A few minutes afterwards, one of the horse-boys brought me a specimen of *G. tachinoides*, which he said he had caught on the horse, and I then became aware of the presence of the flies in the village, although I had been told that they did not exist there. This fact I have taken as possibly indicating that the flies are extending their habitat along the river which flows close past the village.

Leaving the village we immediately entered the "bush," passing through rank grass, varying from a foot to 8 or 10 feet in height. The general country is flat, with slight undulations, and is fairly thickly wooded, the trees being mostly about 12 to 20 feet high, but a fair number of large shady trees exist along the course of the tortuous river-bed. Here and there occurred patches of dense jungle, quite impossible to penetrate, whilst there are also fairly large open spaces. We followed a course close to the river, which flows northwards in a well-defined river-bed, sandy at the bottom, with steep mud banks, 10 to 15 feet high; but we saw very few tsetses.

After proceeding five or six miles, the tent was pitched in an open place, overlooking the river-bed, on the top of a high vertical bank. At that time there was no actual flow of water in the river, merely isolated stagnant pools. At this

spot we saw several tsetse-flies, which bit the men's legs. The evening was dull with a little thunder and rain, and the flies kept on appearing till almost dark, after which none were seen or heard, but mosquitos were very plentiful. My guide had not expected to find tsetse-flies here, and the next morning we continued the journey some couple of miles further to a spot in the bush, called "Abbakudda," the word "kudda" meaning a fly. There was no village here, merely the locality where I was told I should find plenty of flies, and the fact that the place has been given a definite name affords some evidence as to the permanence of this fly-belt. We walked slowly along the river-bed for some distance, but no flies were seen. It was a dull, muggy morning, and about

Fig. 1.—General view of the partially dried river-bed near Pyem, Bornu, where *G. tachinoides* and *G. morsitans* were found.

8 a.m. I shot a waterbuck, one of two which we found close to the river. The blood of this animal was examined but no trypanosomes were found.

Game is said to be plentiful in the neighbourhood all the year round, waterbuck, kob, West African and Senegal hartebeeste, roan antelope, reedbuck, red-fronted gazelle, some bush-cow, and occasionally a few elephants visit the district. We saw no evidence of crocodiles, but I know that they exist in the same river at a place some 15 miles higher up (south). We also saw and heard large numbers of baboons.

It was not till nearly 10 a.m., when the sun broke through and dispelled the clouds, that the tsetse-flies began to appear, and during the rest of the day, till late afternoon, when we left, during which time the sun shone brightly, they were

very numerous, attacking the men vigorously. They also bit me freely through white canvas leggings and khaki breeches.

Walking along the river-bed, I noticed that the flies were numerous at certain spots, while at others, none were seen. Wherever they were numerous, there was always a pool of water near by, and I found the flies to be sheltering in the low spreading straight-stemmed bushes, shown in the photograph (fig. 2), close to the

Fig. 2.—River-bed near Pyem ; tsetse-flies were observed to shelter specially in the bushes shown on either side of the fore-ground.

pools. On shaking these bushes, several more flies were seen, though we failed to observe a single fly actually at rest upon them. After biting the men, the flies disappeared, and it seemed impossible to discover their actual place of rest, but it was obvious that they retired into these bushes, for on shaking them the flies reappeared at once. We very carefully searched the sand and soft mud in the vicinity of the bushes for pupæ, but failed to find any. The small trees and thorny bushes around did not appear to harbour any flies, for when shaken no increase in the number of tsetses was observed.

I had my table set down on the edge of a clear space some 300 or 400 yards from the river-bed, and thither the flies followed me, and were so troublesome

that I was obliged to move further away, and even at a distance of half-a-mile a few flies were seen, which had probably followed us from the river.

It was noticed that all the men adopted the same method of catching the flies, namely, after first allowing the fly to bite freely, a broad-bladed knife was cautiously brought up from behind, and carefully placed over the hind tarsi.

Fig. 3.—Native catching *Glossina tachinoides* with a knife, at Wajerou, Hawal River, South Bornu.

After alighting on the bare skin of the native—nearly always in the region of the lower legs and ankles—the flies waited for about $\frac{3}{4}$ of a minute before piercing the skin, and then they quickly filled themselves with blood, and if undisturbed they took to wing again within two minutes, or less. On several occasions, I observed blood-stained fluid escaping from the hind-gut before the fly had finished its meal.

The bites of the flies caused a good deal of itching, which lasted well into the next day, but there was no noticeable local swelling of the part. All the specimens collected were identified by Mr. Austen as *G. tachinoides*, with the exception of one, which was *G. morsitans*.

It seems probable that the tsetse-flies have inhabited the course of this river, for a distance of ten miles or more, for a considerable number of years, and they do not appear to have spread very much, the "belt" being a strictly local one. Unfortunately I was able to spend only two days (21st and 22nd July) in this vicinity.

Another tsetse-belt was found in Bornu, this time all the specimens collected (about 80 in number) being *G. tachinoides*, as identified by Mr. J. J. Simpson,

Travelling Entomologist for the Research Committee. This belt, which also appears to be a restricted one, lies along the course of the river Hawal, which flows south-west into the river Gongola, a tributary of the Benue.

I paid a visit to the district on 18th and 19th September, 1910, in consequence of native information to the effect that 2 years ago, the headman of Dumboa and his followers had gone into the district, about 30 miles from their town, for the purpose of collecting taxes, and had taken with them about 20 horses. They remained there only two days, and then returned to Dumboa. Within a short time all the horses began to sicken, the chief symptoms being refusal of water and food, and enlargement of the scrotum, with some slight swelling of the legs, and within a period of three months every horse was dead.

Fig. 4.—Hawal valley, at Wajerou, South Bornu; view from top of ironstone bluff bounding the valley; *Glossina tachinoides* was caught here on 18th September, 1910.

The people of Dumboa did not appear to be acquainted with the appearance of tsetse-flies, and they attributed the cause of the death of the horses to some "very small thing that lives in the grass." On my announcing my intention of visiting the spot to ascertain the cause of death of the horses, I was told that I should not find anything, that the "small thing" was so minute as to be invisible to the naked eye. Amongst the people living in the villages close to the river itself, a belief was prevalent that the horses had died from eating some poisonous grasses.

The country here is much more undulating and well wooded, and during the rains is hidden in long rank grass, which is burnt every year as soon as it is dry. The river flows in a broad valley, bounded by ironstone bluffs and slopes, and

along the course of the valley numerous giginia palms occur. Game is said to be plentiful in the vicinity all the year round, though we actually saw very few tracks, but baboons were abundant. During the dry season, when the river is almost entirely dry, the flies are said to be scarce. I was informed by several natives that at that season, the flies go into the bush to the south-east, apparently some considerable distance away, to places where water exists all through the dry season.

Having arrived at Wajerou, a small village standing some 500 or 600 yards from the river, a little way back from the ironstone bluff, which here borders the valley, we looked about the village for tsetse-flies, but saw none. The river then had about three or four feet of water in it, and flowed quickly in a well-defined channel about 10 yards wide, with muddy banks, and with here and there some igneous rocks and a little sand and clay. Descending to the river-bed, we walked slowly along, but did not see any flies until we passed close to a low leafy bush, shown in one of the photographs (fig. 3), when a large number of flies suddenly appeared and fed voraciously on the men, settling on their ankles and legs.

Fig. 5.—Hawal River, at Gellen, near Wajerou.

The flies did not seem inclined to travel far from the bush. Those men standing close to it had as many as five or six flies on them at one time, while men standing a few yards away were quite unmolested, and if nobody stood near the bush hardly any flies appeared. On shaking the bush, large numbers of flies came out, and after feeding, quickly retired once more to the shelter of the bush. Again we failed to observe a single fly actually at rest on the bush, and we were also unsuccessful in our search for pupæ in the moist soil around.

Continuing through the long grass along the river-bank, in most places no flies were to be seen, but at particular spots a few would appear, though it was impossible to find out where they came from. Returning to the village about 5 p.m., a few flies followed us, and were very persistent in their attempts to obtain a feed of blood. At another part of the river, about half an hour later, we found the flies numerous at a spot where the natives generally draw their water. They appeared to come out of a particular thicket, but of this I am not at all certain. They continued to bite in gradually diminishing numbers till dark, when they entirely disappeared.

The next day we proceeded up-stream for six or seven miles, and again found that *G. tachinoides* occurred intermittently in restricted patches along the route; but we did not observe any beyond Gellen. Numerous villages occur along the banks, and to the inhabitants the flies are well known, under the name of "tatchiga." They said that these insects were a perfect nuisance in the middle of the day, giving the people no peace at all.

On first going down to the river at Gellen, we sat down for a few minutes on the rocks shown in the photograph (fig. 5), and no flies appeared, but after about ten minutes, one or two were seen about us, and they gradually increased in numbers till they became quite numerous. On sending a few men to the opposite side of the river, it was found that the tsetses were much more numerous there, and seemed to come out of the bushes shown immediately behind the two standing figures (fig. 6).

Fig. 6.—Hawal River, at Gellen, near Wajerou; *G. tachinoides* appeared to be harbouring in the bushes above the heads of the natives.

On investigating the "bush" some 400 or 500 yards on either side of the river, no flies were seen at all, and at one or two small villages, situated a mile or so from the river, I was informed that the flies never appear there. So that apparently the "belt" is confined to the immediate course of the river Hawal, and as far as I was able to ascertain, extends for at least ten miles along the river, the tsetses living at particular spots only, the intervening spaces being normally free from them, except when the flies follow human beings who traverse these areas.

These two isolated and comparatively restricted fly-belts would seem to afford very favourable conditions for studying the factors which determine the distribution of these particular species of *Glossina*; but the investigation would necessitate a residence of at least some months in the vicinity.

The fact that the flies are so curiously localised even within the limits of the fly-belt may prove of some importance; and it might be possible to ascertain what it is that influences them to congregate, as they do, about certain particular bushes.

RESULTS OBTAINED FROM A MONTHLY EXAMINATION OF THE NATIVE DOMESTIC WATER-RECEPTACLES AT LAGOS, SOUTHERN NIGERIA, IN 1910–1911.

By Dr. W. M. Graham,
Director of the Medical Research Institute, Lagos.

Last year an attempt was made to collect the mosquito larvæ breeding in the vicinity of the Institute at Yaba, near Lagos, and to identify them with their imagines. This year it was decided to conduct a similar investigation in the township of Lagos itself. My attention had been directed to the importance of the subject by the occurrence of an outbreak of Yellow Fever in Sierra Leone and the Gold Coast; and further, I had been requested to suggest a set of instructions such as would enable the native Sanitary Inspectors in Lagos to identify the larva of *Stegomyia fasciata*.

Inherent difficulties rendered it impracticable to draw up any instructions which would enable the native Inspectors to make correct identifications, and the matter seemed of sufficient importance to warrant a complete investigation of the domestic mosquito fauna of the Lagos township.

The investigation was conducted in the following manner. I arranged with the Sanitary Department to have the native Sanitary Inspectors instructed to empty the contents of each water-receptacle in native yards, found to contain mosquito larvæ, into suitable bottles, which, when labelled with the letters of the Sanitary Division and District and the date of collection, were to be forwarded daily to the Laboratory.

On arrival there, the contents of each bottle were transferred to a shallow white tray, and examined with a hand-lens, and the various species isolated for more detailed examination, or for breeding experiments. As the relative importance of separate facts is usually obscure at the beginning of such an investigation, I determined to identify and tabulate as completely as possible all living creatures found.

The investigation was begun in August, 1910, by the examination of the contents of 364 water-receptacles from native yards in the four Sanitary Divisions of the township. I further asked to be supplied monthly with the contents of at least 100 water-receptacles from these 4 divisions. The collection of these samples was efficiently carried out, except during the months of November and December, when the contents of only 43 and 61 receptacles respectively were received at the Institute.

In practice, this method of ascertaining the mosquito fauna of a native town has proved relatively easy of execution; the results have proved more accurate and complete than those obtainable by other methods; and any seasonal variation in numbers or distribution can be very readily observed. The catching of mosquitos in native yards and houses is difficult, and offers none of the advantages gained by dealing with the larvæ, and even approximate finality is

PLAN OF
TOWN OF LAGOS

impossible without actual residence, as the mosquito of one house is not always that of the next. The superior accuracy and finality obtained by dealing with the larvæ breeding in the native yards of the township is apparent, and I hope that a similar examination of the larvæ of each native town will be attempted. We shall then be placed in a position to compare accurately the geographical distribution of the mosquitos with that of the indigenous diseases. Very useful information will, I feel sure, be obtained by such a comparison, for all the chances are in favour of that insect, which breeds and lives in the immediate vicinity of human dwellings, playing a preponderating part in the transmission of human diseases. Such a study of the larvæ would also supply the materials required for the accurate identification of really distinct species; a subject which is at present in considerable confusion.

The results obtained by 8 months' investigation are presented below in tabulated form, and furnish some surprises. But to render the tables intelligible it will be necessary first to explain shortly the geography of the places named in them.

The town of Lagos is built upon the islands of Lagos and Iddo, which are connected by a long bridge. These islands are sandy, low-lying and swampy. It will be seen on the map that the town is divided into 4 Sanitary Divisions, A, B, C, D, each of which is sub-divided into districts lettered alphabetically.

Ebute Metta is a town built upon the mainland, being joined to Iddo by a long bridge. It is the headquarters of the Government Railway, and is surrounded by swamps.

During the eight months, August to March inclusive, 18 different species of insect larvæ, of which 6 were mosquitos, and 5 Crustaceans were found in the native domestic water-receptacles examined, as shown in the following list : —

Insect Larvæ.

Stegomyia fasciata, F.
Pectinopalpus fuscus, Theo.
Culex duttoni, Theo.
Culex tigripes var. *fusca*, Theo.
Culex nigrocostalis, Theo.
Pyretophorus costalis, Loew.
Chironomus (3 species).
Psychoda (2 species),
Drosophila (1 species).
Ephemeridæ.

Crustacea.

Cyclops simillimus, Brady.
Daphnia sp.
Cypris (2 species).
Atthegella africana, Brady.

Table showing Insect Larvæ and Crustaceans found in Domestic Water-Vessels in Native Yards at Lagos and Ebute Metta, Southern Nigeria (1910–1911).

	August, 1910.			September.			October.			November.			December.			January, 1911.			February.			March.			Total number of Vessels.
	Lagos.	E. Metta.	Totals.	Lagos.	E. Metta.	Totals.	Lagos.	E. Metta.	Totals.	Lagos.	E. Metta	Totals.	Lagos.	E. Metta.	Totals.	Lagos.	E. Metta.	Totals	Lagos.	E. Metta.	Totals.	Lagos.	E. Metta	Totals.	
Stegomyia fasciata.	333	10	343	127	5	132	108	3	111	43		43	57		57	89	4	93	86	9	95	81	10	91	965
Pectinopalpus fuscus.	29	2	31	16	0	16	14	1	15	9		9	10		10	41	2	43	20	1	21	40	3	43	188
Culex duttoni ...	6	28	34	7	12	19	3	9	13	0		0	4		4	1	6	7	2	7	9	3	9	12	98
Culex tigripes var. *fusca.*	13	3	16	1	2	3	9	1	10	0		0	5		5	3	0	3	2	2	4	8	4	12	53
Culex nigrocostalis.	1	0	1	0	2	2	2	0	2	0		0	1		1	0	0	0	1	3	4	3	3	6	16
Pyretophorus costalis.	6	0	6	1	0	1	1	0	1	1		1	0		0	3	0	3	6	0	6	1	0	1	19
Chironomus spp.	102	5	107	40	2	42	31	1	32	7		7	10		10	11	0	11	15	1	16	13	2	15	240
Psychoda spp.	10	0	10	7	0	7	3	0	3	4		4	5		5	16	1	17	7	1	8	10	0	10	64
Drosophila sp.	1	1	2	0	0	0	0	0	0	0		0	2		2	3	0	3	4	0	4	0	0	0	11
Ephemeridæ. ...	0	0	0	0	0	0	0	0	0	0		0	0		0	0	1	1	1	0	1	0	0	0	2
Cyclops similimus.	129	2	131	31	0	31	16	0	16	8		8	21		21	19	1	20	18	2	20	8	1	9	256
Daphnia sp. ...	0	0	0	0	0	0	0	0	0	0		0	0		0	0	0	0	2	0	2	0	0	0	2
Cypris sp.	7	0	7	1	0	1	0	0	0	0		0	1		1	3	0	3	4	0	4	2	0	2	18
Atthegella africana.	0	0	0	0	0	0	0	0	0	0		0	0		0	0	0	0	1	0	1	0	0	0	1
Total No. of V.	335	29	364	130	13	143	109	10	119	43	—	43	61	—	61	96	9	105	94	14	108	88	12	100	1043

No Samples sent.

No Samples sent

These figures indicate the actual number of vessels in which larvæ, &c. were found.

Seasonal Variation of Mosquito Larvæ in Domestic Water-Vessels at Lagos and at Ebute Metta (1910–1911).

1910.	*Stegomyia fasciata.*		*Pectinopalpus fuscus.*		*Culex duttoni.*		*Culex tigripes* var. *fusca.*		*Culex nigrocostalis.*		*Pyretophorus costalis.*	
	Lagos.	E. Metta.	Lagos.	E. Metta.	Lagos.	E. Metta.	Lagos.	E. Metta.	Lagos.	E. Metta.	Lagos.	E. Metta.
August ...	99·4	34·4	8·6	6·8	1·8	96·5	3·8	10·3	0·3	0·0	1·7	0·0
September ...	97·6	38·4	12·4	0·0	5·3	92·3	0·7	15·3	0·0	15·3	0·7	0·0
October ...	99·0	30·0	12·8	10·0	3·5	90 0	8·2	10·0	1·8	0·0	0·9	0·0
November ...	100·0	—	20·9	—	0·0	—	0·0	—	0·0	—	2·3	0·0
December ...	93·4	—	16·3	—	6·5	—	8·1	—	1·6	—	0·0	0·0
1911.												
January ...	92·7	44·4	42·7	22·2	1·0	66·6	3·1	0·0	0·0	0·0	3·1	0·0
February ...	90·1	64·2	22·3	7.1	2·1	50·0	2·1	14·2	1·0	21·4	6·3	0·0
March ...	92·0	83·3	45·4	25·0	3·4	75·0	9·0	33·3	3·4	25·0	1·1	0·0
Aver. monthly percentages	95·5	49·1	22·7	11·8	2·9	78·4	4·4	13·8	1·0	10·3	2·0	0·0

Mosquito Larvæ.

Stegomyia fasciata, F.

This larva was present in an average of 92·5 per cent. of the total water-receptacles examined. It is the commonest species of larva, is widely distributed over the township, and is found in all varieties of water-vessels. It is hardy and not much affected by environment, living in both clean and foul water with equal facility. Its chief natural enemy in these water-receptacles is the large carnivorous larva of *C. tigripes* var. *fusca*, Theo. At Ebute Metta the species is apparently less common, but the number of samples received from that locality was too small for certainty. A slight monthly variation in numbers is shown in the tables.

Pectinopalpus fuscus, Theo.

This larva was present in an average of 21·6 per cent. of the total receptacles. It is, therefore, the next commonest larva to *S. fasciata*. Usually it is found in vessels containing foul water contaminated with animal excreta, or in water that

has been used for washing clothes, &c. It is very frequently associated with *S. fasciata* in the same vessel and, like it, is found in both pots and barrels. It is commonest in pots, probably because the foulest water is usually found in these vessels. Early in the investigation my attention was aroused by the strange frequency with which this larva occurred, for it seemed improbable that the mosquito of the second commonest larva of Lagos should have remained unrecognised by previous observers, and should have continued since 1907 to be represented by a few males collected in Ashanti. As the insect evidently belonged to the genus *Culiciomyia*, from which it has been separated on account of the peculiar scales on the male palpi, I determined to examine the types of that genus at the British Museum when I reached London.

On doing so I found that the scales on the male palpi of *Pectinopalpus* were not peculiar to that genus. A detailed examination of the male genitalia of both genera would be desirable, but in its absence it seems to me that *Pectinopalpus fuscus*, Theo., is likely to prove a synonym of *Culiciomyia freetownensis*, Theo. This larva showed monthly variation in numbers and appeared to be commoner at Lagos than at Ebute Metta.

Culex duttoni, Theo.

The larva of this mosquito occurred in an average of 8·3 per cent. of the total receptacles examined. Its distribution is apparently greatly influenced by environment. As shown in the tables, it is rare in Lagos, but at Ebute Metta it is the commonest larva with an average of 78·4 per cent. Seeking an explanation of this difference in distribution, an analysis was made of three samples of water received from Lagos receptacles which did not contain this larva, and of the three samples from Ebute Metta water-receptacles in which the larva had been found, with the results shown below :—

Lagos.		Ebute Metta.	
1. Chlorine	... 2·4 parts per 100,000	1. Chlorine	... 1·4 parts per 100,000
2. „	... 3·6 „ „	2. „	... 1·4 „ „
3. „	... 15·0 „ „	3. „	... 1·8 „ „

Apparently then this species prefers water containing only a small amount of chlorine, and is sensitive to any great variation in its amount. It also shows a seasonal variation in numbers.

During the progress of this investigation three native patients suffering from Calabar swelling were sent to the laboratory for the purposes of diagnosis. *Filaria diurna* was readily found in the peripheral blood, and all three natives lived on the mainland (two at Ebute Metta and one at Agage, an adjacent

village). These facts, when considered in conjunction with the peculiar distribution of *C. duttoni*, its sensitiveness to environment making it common in some localities and uncommon in others, the fact that it feeds during the daylight, and that it is a domestic mosquito, make it appear possible that this species may be the carrier of this *Filaria*.

Culex tigripes var. fusca, Theo.

This species was found in an average of 5·3 per cent. of all the water-receptacles. As far as I have observed it is wholly carnivorous, living entirely upon other larvæ, or on those of its own species when deprived of more suitable victims. It showed preference for the larvæ of *S. fasciata* and of *C. nigrocostalis*, but in their absence, and after a little starvation, will eat the larvæ of *C. duttoni* and of *Pectinopalpus fuscus*. The presence of *tigripes* larvæ in the samples of water examined has probably led to an under-estimate of the number of both the larvæ it prefers, as several hours always elapsed between the collection of the samples and their examination at the Laboratory. This larva is the chief natural enemy of domestic mosquito larvæ. It showed a seasonal variation in numbers.

Culex nigrocostalis, Theo.

This larva was present in an average of 1·8 per cent. of the total water-receptacles. It is a small, delicate, long-syphoned larva, easily injured by change of normal environment. As it is a favourite food of *C. tigripes*, its occurrence has very probably been under-estimated. It shows seasonal variation in numbers and appears to be commoner at Ebute Metta than at Lagos.

Pyretophorus costalis, Loew.

The larva of this species was found in an average of 1·8 per cent. of all the water-receptacles examined. It has become almost an axiom that Anopheline larvæ need only be sought in pools and puddles, or other natural collections of water. The discovery that *P. costalis* breeds habitually in the domestic pots and barrels of native yards is therefore of some importance. Of 1,043 water-vessels examined in eight months 19 were found to contain this larva. Both larvæ and pupæ were found and were successfully reared in the Laboratory, so that it is likely they also reached maturity when left undisturbed in native yards.

From the tables it will be seen that on an average 2 per cent. of the vessels in Lagos harboured this larva, and that in the month of February, 1911, this average rose to 6·3 per cent. Possibly this rise was caused by the absence of suitable puddles or pools at the end of the dry season. The species was not found in the samples of water from Ebute Metta, but as only 87 such samples were received the possible existence of at least 1·0 per cent. would not be excluded.

At Lagos this species was found in the following Sanitary Divisions and Districts of the township :—

Division	A	...	Districts	C., E., Q., S.
„	B	...	„	K., M.
„	C	...	„	H.
„	D	...	„	H., I., M.

It may be noted that these Districts are mostly situated on that edge of the island having the lowest elevation above sea-level.

Other Larvæ.

Chironomus (3 species).

Species of this genus were present in 23·9 per cent. of the total water-receptacles. These larvæ ("blood worms") are commonly found in pots and barrels, and even in the large covered iron tanks used to collect rain-water from the roof.

Psychoda (2 species).

Species of this genus were present in 6·1 per cent. of the receptacles. The water in which they were found was usually extremely foul and often contained sewage.

Drosophila (1 species).

This species occurred in 1·0 per cent. of the receptacles examined, and a few of the pupæ were reared for identification purposes.

Ephemeridæ.

Larvæ were found in only 2 out of 1,043 receptacles examined.

Crustacea.

Cyclops simillimus, Brady.

This species was present in an average of 24·5 per cent. of all the water receptacles examined. The fact is of considerable importance in relation to the transmission of Guinea Worm, for natives frequently wash their feet in such vessels, and if suffering from Guinea Worm would, during such ablutions, infect any *Cyclops* present. Apparently therefore it is not necessary to go to water-holes or public wells to find a source of Guinea Worm infection.

This species of *Cyclops* was originally found by me in the Gold Coast, where it was common in the borrow-pits along the railway. In Freetown Guinea Worm is a rare disease, while at Accra it is a common one. It would therefore be interesting to compare the distribution of this *Cyclops* in the two towns.

Cypris (2 species).

Species of this genus occurred in an average of 1·3 per cent. of the total receptacles. These Ostracods have been found in Europe to harbour *Tænia*, Trematode larvæ and *Acanthocephalus*, and therefore deserve further attention.

Daphnia sp.

Specimens of this genus were found in only 2 out of 1,043 receptacles examined.

Atthegella africana, Brady.

This species was present in large numbers but only in one receptacle examined. It was originally found by me in the Gold Coast.

Summary.

1. The examination of the contents of the domestic water-receptacles was found to be a practical and accurate method of studying the mosquito fauna of a township.

2. During the investigation the following points were found to be of importance :—

α. The Division and District of the township ; for in Lagos conditions differ in different Divisions.

β. The variety of water-receptacles (deep or shallow) ; for some larvæ prefer barrels to pots, and *vice versa*.

γ. The nationality of the householder. The food of the different nationalities differs, and water-vessels usually contain particles of food upon which larvæ may be observed to feed.

δ. The extent of the distribution (Coast line and Inland). The water on the Coast line is mostly brackish, that of the interior is usually almost free from chlorides.

3. A seasonal variation in numbers was shown to occur, but the causes were obscure.

4. Sensitiveness to change of environment was found to exist in some cases, and in one was supposed to depend upon the amount of chlorides.

5. Two active natural enemies of mosquito larvæ were found to exist.

6. It was found that both larvæ and pupæ were killed by raising the temperature of the water above 45° C.

7. *Stegomyia fasciata* was found to be the commonest mosquito and very widely distributed.

8. *Pyretophorus costalis* was found to breed habitually in the domestic water-vessels of the native yards.

9. The water in many of these vessels was found to be very foul and in many cases contained sewage.

10. *Cyclops* and other Crustaceans were found to inhabit and breed in the native yards.

11. The simultaneous and apparently sympathetic variations of certain species are shown by the tables.

London, 8 June, 1911.

A FISH THAT PREYS ON MOSQUITO LARVÆ IN SOUTHERN NIGERIA.

By Dr. W. M. Graham,

Director of the Medical Research Institute, Lagos.

During a seach for mosquito larvæ at Yaba, near Lagos, my attention was drawn to their complete absence from a swamp about a mile from the Medical Research Institute. The pools in the swamp appeared to be well suited for the growth of mosquito larvæ, and I caught female mosquitos full of eggs in the adjoining fringe of bush. The absence of larvæ was therefore evidently not due to any lack of fertile female mosquitos. An examination of the pools showed that they all contained small, active, surface-feeding fish,* belonging to the family Cyprinodontidæ, and it seemed probable that it was by their agency that the pools were kept free from larvæ.

To test this hypothesis, a number of the fish were caught and taken to the Laboratory in a large jug of swamp water, and the contents of the jug were then emptied into a basin and put aside, as it was getting dark. The following morning a number of the fish were found dead on the floor, owing to their having jumped out of the basin during the night. As these fish can leap a distance of from one to two feet, in all future experiments it was found necessary to keep them in covered vessels.

On watching the fish in their native haunts, the importance of this faculty of leaping becomes plain, for it is by this means that they are enabled to pass from pool to pool. Thus every pool in a swamp is likely to be visited, and the whole food supply will be better distributed among the fish. No other species of fish were found in the swamp, and the *Haplochilus* itself was absent from a dug-out water-hole near the swamp, in which I found tadpoles.

At the Laboratory, the *Haplochilus* were found to eat mosquito larvæ greedily. Even when a hundred larvæ were introduced into a vessel with a dozen fish, all the larvæ had disappeared in an hour. I was unable to discover that preference was shown for any particular species of larvæ, though I tried the fish with one Anopheline, and five species of Culicine larvæ. They declined, however, to eat pupæ of any species, though they nibbled at them occasionally. Probably these fish are unaccustomed to see pupæ, for in the pools they inhabit the larvæ would be very unlikely ever to reach that stage of development.

* Mr. Boulenger has supplied the following notes on the structural characters of the species, for which he proposes the name *Haplochilus grahami*, sp. n. :—

"Allied to *H. senegalensis*, Steindachner. Depth of body, 4 to 4½ times in total length, length of head, 3 to 3⅓ times. Snout a little shorter than eye, which is 3 to 3¼ times in length of head, and 1½ times in interorbital width : lower jaw projecting. Dorsal with 7 rays, originating about twice as far from occiput as from root of caudal, above posterior fourth of anal. Anal with 15 or 16 rays. Pectoral, ¾ length of head, extending beyond base of ventral : latter small, equally distant from end of snout, and from root of caudal. Caudal rounded-acuminate, longer than head. Caudal peduncle slightly longer than deep. 28 or 29 scales in a longitudinal series, 22 round body in front of ventrals ; lateral line indicated by a series of pits."

The shady pools frequented by *Haplochilus* are only a few yards long or broad, and are dotted over a large swamp. The water in them is clear, the bottom being of mud, decaying leaves and twigs, and when the shade is not too great, they contain green reeds and water-plants. On analysis, the water of these pools was found to contain only 0·84 grain of chlorine per gallon, though the swamp is little more than a mile from the Lagoon.

As an experiment, some of the fish were placed in a basin of water taken from the large water-hole near the swamp, referred to above. This water is of a milky opacity, and does not become clear after standing. By analysis the amount of chlorine was found to be 0·91 grain per gallon. The water was so opaque that the fish could only be seen when close to the surface. Mosquito larvæ introduced into the basin disappeared somewhat more slowly than they did in clear water, but they were ultimately all destroyed, and the fish did not appear to be injuriously influenced by the change of water. The *Haplochilus* were also found to flourish in tap-water, so long as they were fed with mosquito larvæ.

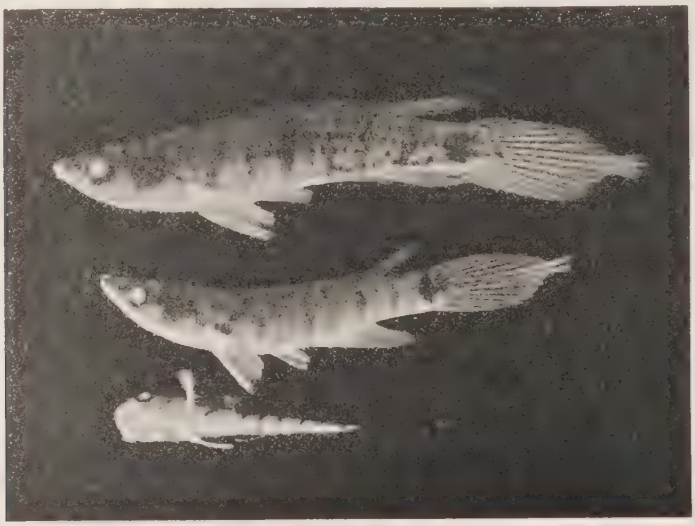

Fig. 1—*Haplochilus grahami*, Blgr. × 2.

The hypothesis therefore seems to me established, that the presence in the swamp-pools of these fish effectually prevents the breeding of mosquitos, and the question presents itself as to whether they can be employed to produce the same result in ponds, water-holes, water-barrels, &c., elsewhere. It should be remembered that these fish have a great capacity for spreading themselves over flooded land by leaping from pool to pool. As this part of the country is low-lying and frequently flooded, it is probable that if they are not found in a particular pool, it is because they cannot live there. Most of the water-holes contain cat-fish which would be likely to destroy any small fish introduced, especially when, as in this case, they are also conspicuous and defenceless. It seems likely, therefore, that it is only in pools free from other fish that the

introduction of *Haplochilus grahami* would be successful. They might also be tried in domestic water-barrels and tanks, if means were devised to prevent them from leaping out on to the ground.

The following is a description of the colouring of the species, based on living specimens :—

Haplochilus grahami, Blgr.

Colour, yellowish, with blackish brown markings upon the body. The fins are semi-transparent, and in the males especially, of a brilliant greenish yellow colour. In front of the base of the anal fin there is a large dark spot, from which 6 longitudinal lines, formed of smaller spots, run forward to the head. Six dark, transverse, almost equi-distant bands extend from back to belly, and there is an ill-defined large dark spot behind the eye. On the caudal fin, towards the base, are 3 to 4 transverse rows of dark spots, and the apex of the fin is drawn out into an irregular point or points. In both sexes the occiput is flattened, and bears a nearly circular spot of burnished silver. This spot is not luminous at night.

The females are larger and less brilliantly coloured than the males. The markings are less distinct, the silver spot on the occiput has a rubbed appearance, and the fins are not so bright a yellow. Length, 18 to 40 mm.

I have to thank Mr. G. A. Boulenger, of the British Museum, for identifying my specimens.

The accompanying photograph was taken on a colour-sensitive plate through a yellow screen, and represents a magnification of two diameters.

London, 31st May, 1911.

SOME NEW WEST AFRICAN SPECIES OF ANOPHELES (SENSU LATO), WITH NOTES ON NOMENCLATURE.

By F. W. Edwards, B.A.

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In describing the following new species from West Africa, some words of explanation are needed as to the generic names used. In the first place, it is necessary to say that the writer follows Messrs. Dyar and Knab in considering that most of the genera into which Meigen's genus *Anopheles* has recently been split up are not genera in any accepted sense, and should sink under the old name *Anopheles*. Provisionally, however, *Stethomyia*, *Chagasia*, *Calvertina* and *Bironella* are considered as distinct; as none of these genera are African, this will not affect the present paper. Lieut.-Col. A. Alcock, of the London School of Tropical Medicine, has kindly allowed me to see the manuscript of a paper on the classification of *Anopheles*, which he is about to publish in the Annals and Magazine of Natural History, and I have been able to concur entirely with his views; he recognises only five sub-genera of *Anopheles*, the sub-genus *Nyssorhynchus* including all those species with flat scales on thorax and abdomen, *i.e.*, the genera *Nyssorhynchus*, *Cellia* and *Neocellia* of Theobald's Monograph.

It may be as well to point out that whether this course be adopted or not, certain other changes of nomenclature will be necessary. In his original paper on the classification of the Anophelinæ (Journ. Trop. Med. II., 1902, p. 181), Theobald designated *Anopheles rossi* as the type of his genus *Grassia* (*Myzomyia*, Blanchard), and *A. argyrotarsis* as the type of *Laverania* (*Nyssorhynchus*, Blanchard). Although he subsequently (Mon. Cul. III., pp. 12–14) altered the type-species, the original types must stand, having once been published. This means that James' *Nyssomyzomyia* must sink as a synonym of *Myzomyia*, and Theobald's *Cellia* as a synonym of *Nyssorhynchus*. If it is desired to retain as distinct the group James has called *Nyssomyzomyia*, it must be known as *Myzomyia*, and the species included under *Myzomyia* by James must be given a new name. In the same way Theobald's *Cellia* becomes *Nyssorhynchus*, while if the group *Nyssorhynchus* (as used by Theobald in the fifth volume of his Monograph) be retained as a genus or sub-genus, it will also require renaming. It should further be noticed that in his paper on the Indian Anophelinæ (Rec. Ind. Mus., Vol. IV., No. 5, Nov., 1910), Captain James has incorrectly cited the type-species of the genera *Myzomyia*, *Pyretophorus*, *Nyssorhynchus*, *Cellia* and *Myzorhynchus*. Captain James says of the genus *Stethomyia*, "probably all the species now assigned to it would come in my new genus *Neostethopheles*." If this is the case, *Neostethopheles* sinks as a synonym of *Stethomyia*. I have examined the types of *A. aitkeni* and *A. immaculata* in the British Museum; the former appears to be a true *Stethomyia*, but the latter has head-scales of quite the ordinary type.

Anopheles (Myzomyia) umbrosa, Theo.

Myzomyia funesta var. *umbrosa*, Theobald, Mon. Cul. III., p. 34 (1903).

Mr. G. A. K. Marshall has shown me five specimens of this species which have been sent to the Entomological Research Committee by Dr. T. F. G. Mayer, W.A.M.S., who found them at Oshogbo, Southern Nigeria, in December, 1910. They agree closely with the type, and are evidently quite distinct from *A. funesta*. One of the most striking characters of the species, which Theobald does not mention in his description, is that the palpi are only whitish at the tip, otherwise having no pale bands. This peculiarity alone will suffice to differentiate the present species from any other of the group *Myzomyia*, while when the wing markings are taken into account it is clear there is no very close relationship between *A. funesta* and *A. umbrosa*. In *A. umbrosa* the first fork-cell is slightly shorter than the second, another important difference from *A. funesta*, in which the first fork-cell is markedly the longer.

Anopheles (Myzomyia) flavicosta, sp.n. ♀.

Wings yellow, especially towards the costa. Four black costal spots, the apical one very small. Five pale fringe-spots, apart from the yellow apex. Legs with narrow apical pale bands. Palpi with three pale bands, the two apical ones equally broad.

♀. *Head* with the usual type of scaling : a tuft of very long white scales on the occiput, a patch of white upright forked scales in front, remainder of these black. Antennæ clothed with whitish hairs, segments 2–4 with a few white scales. Palpi rather thin, but shaggily scaled towards the base : a narrow white band between the first and second joints, a broad one before the apex, and another equally broad at the tip. Proboscis pale at the tip. *Thorax* with the ground-colour ashy-grey above, brown at the sides. Mesonotum with white narrow curved scales, which are longer and more numerous in front. Prothoracic lobes without scales. Scutellum with about 10 long brownish bristles, and hair-like white scales. *Wings* with the scales mainly yellow, on costa and first vein deep yellow. Costa black at the base, and with four black spots, which extend on to the first vein ; the fourth is very small and extends also on to the anterior branch of the second vein. Third vein almost entirely yellow-scaled. Dark areas on the other veins are distributed as follows : nearly the whole of the stem of the second fork-cell ; two small spots on the anterior and one on the posterior branch of the fourth vein : near the base of the fifth vein and at the base of its anterior branch ; near the tips of the two branches of the fifth and of the sixth veins. Fringe dark grey, with five yellow spots, at the terminations of the fourth, fifth and sixth veins ; yellow round apex of wing. Stem of halteres yellow, knob black. *Legs* dark brown, with narrow, ochreous bands at the tips of the tibiæ and of the first four tarsal joints. *Abdomen* dark brown, covered with golden-yellow hair.

Length of body, 3 mm. ; of wing, 3 m.m.

Northern Nigeria : Baro, 21. X. 1910 (*Dr. A. Ingram*).

Type and one other female, in perfect condition, in the British Museum.

This species belongs to the genus *Pyretophorus* in Theobald's classification, and is closely allied to *A. pitchfordi*, Power, and *A. austenii*, Theo. From both it is distinguished by the *bright yellow costa and first vein* and by the *small size of the fourth costal spot*, while the dark areas on the veins are smaller and less numerous, so that the wing has a less mottled appearance. *A. pitchfordi* is also distinguished from *A. flavicosta* by the presence of a very small fifth costal spot. *A. austenii* has the first two costal spots joined into one, and has broader bands on the legs.

Anopheles (Nyssorhynchus) watsoni, sp.n., ♂ ♀.

Closely allied to *A. maculipalpis*, Theo., and *A. pretoriensis*, Theo. From the former it is distinguished by the absence of spots on the palpi, and from both by the *entire absence of spotting on the legs*. In addition to this, the new species differs from its very near ally *A. pretoriensis* in the banding of the hind tarsi. The hind legs in *A. watsoni* are marked as follows: narrow white bands on the apices of the tibiæ and first two tarsal joints: third to fifth tarsal joints white, except for a dark brown band of variable length near the base of the third joint. In *A. pretoriensis* the white band on the first two tarsal joints are markedly broader, that on the second joint being almost one-third as long as the joint itself. In *A. watsoni*, as in *A. pretoriensis*, there are no scales on the abdomen of the female, and only on the genital segment (occasionally a few also on the penultimate segment) of the male.

There is also a general (though not very close) resemblance between this species and *A. (Nyssorhynchus) aureosquamiger*, Theo. Theobald placed *A. aureosquamiger* in *Pyretophorus*, but as it has numerous flat scales on the scutum it belongs to the sub-genus *Nyssorhynchus*, in the sense in which it is here employed.

This species bears the same relation to *A. pretoriensis* that *A. ludlowi* does to *A. rossi*, and it is a matter of opinion as to whether the spotting of the legs is a specific character or not. Banks regards *A. ludlowi* as a variety of *A. rossi*.

NORTHERN NIGERIA: Katagum, 3 ♂, 13 ♀ (*Dr. C. E. S. Watson*): Minna, 1 ♀ (*J. J. Simpson*).

Types in the British Museum.

ANOPLURA AND MALLOPHAGA FROM AFRICAN HOSTS.

By V. L. Kellogg and J. H. Paine,

Stanford University, California.

(Plates IV and V).

The descriptions of new, and determinations of old, species of Anoplura and Mallophaga presented in this paper are based on a small collection of these ecto-parasitic insects taken from mammals and birds of the Egyptian Sudan and other North and West African localities. The collection was made by various collectors, as indicated for each species, and was submitted to us by Mr. Guy A. K. Marshall, Scientific Secretary of the Entomological Research Committee (Tropical Africa) of the British Colonial Office.

Anoplura.

Pediculis capitis, De Geer.

Specimens from the head of a man (Dinka), near Bor, Egyptian Sudan (*H. H. King*); also specimens from the loin-cloth of a woman (Dinka), Azzar, near Bor, Egyptian Sudan (*H. H. King*).

Hæmatopinus asini (Linn.) Stephens.

From horse, Khar Altar, Angelo, Egyptian Sudan (*H. H. King*).

Hæmatopinus peristictus, sp. n. (Pl. IV, figs. 3 and 6).

Males and females from several wart-hogs (*Phacochoerus æthiopicus*), Akamanga, North Nyasa (*Dr. J. B. Davey*), and from a bush-pig (*Potamochoerus choeropotamus*) Fort Hill, North Nyasa (*Dr. J. B. Davey*).

This striking new *Hæmatopinus* shows similarities with *H. suis* (Linn.) Leach, the common louse of swine, but differs markedly in its short head, the reduced character of its ocular projections, and the arrangement of its markings.

Female.—Length, 5 mm.: width, 3 mm. General colour yellowish brown, with distinct darker (brown to blackish brown) markings on head, thorax, legs and abdomen. *Head* short, as wide as long (in this character differing much from *H. suis*, which has a narrow head, twice as long as wide). Ocular projections slight and blunt. A blackish brown transverse band across the front of the head, and small blackish brown blotches bordering the front of the ocular projections. *Thorax* sub-pentangular, with curving lateral margins and straight anterior and posterior margins. Strongly patterned with blackish brown bars irregularly radiating from a central spot (Pl. IV, fig. 3). Legs very heavy and strong, the tibiæ larger than the femora: with strong blackish brown bands and blotches, as shown in the figure. *Abdomen* three-fourths as wide as long and with the swollen, rounded margins of the segments projecting laterally, although there is only one inter-segmental suture which is distinct (on dorsal surface)

entirely across the abdomen; this is the suture between segments 5 and 6. Last segment angularly emarginate behind, forming two tooth-like pieces; when these pieces are brought together their tips meet behind a small open space. All segments with distinct brownish black lateral blotches just inward from the spiracles, each of which is set in a small brown circular spot; on the middle of the segments are pairs of short lateral brown bars, thicker and shorter on the posterior segments (Pl. IV, fig. 3).

Male.—Length, 4 mm.; width, 2·24 mm. Posterior segment not emarginate (or toothed) but entire and with a conspicuous tuft of several short hairs in each postero-lateral angle (Pl. IV, fig. 6).

Linognathus vituli (Linn.) Dalla Torre.

Specimens from calf, Songwe River, N. Nyasa (*Dr. J. B. Davey*).

Linognathus africanus, sp. n. (Pl. IV, figs. 1, 5).

Males and females from sheep, Abeokuta, Southern Nigeria, W. Africa (*J. J. Simpson*).

This new *Linognathus* is rather near *L. vituli*, the common long-nosed louse of the ox, but has a shorter and broader head, a larger, broader body and the antennæ with the basal two segments curiously large.

Female.—Length, 2·5 mm.; width, 1 mm.; the body of the female is thus only about $2\frac{1}{2}$ times as long as the width of the abdomen, and the head is hardly twice as long as broad. *Head* with the antennæ inserted in front of the middle, the two basal segments being conspicuously larger than the following segments. *Thorax* at its anterior end only slightly wider than widest part of head, but gradually widening posteriorly. The lateral margins are straight, slightly diverging lines, showing some brown coloration and chitinous thickening, with short tapering brown chitinized lines projecting diagonally towards the middle of the segments. Pro-, meso-, and meta-segments all so fused as to be hardly distinguishable. One pair of longish, strong, almost spine-like hairs on dorsal surface of the meso-segment, the whole thorax otherwise without hairs. *Abdomen* broader in relation to its length than in *L. vituli*, and with entire, flatly convex margins. The segments are so fused that they are distinguishable only by the position of the spiracles and transverse dorsal rows of short hairs, there being five of these rows, one of which is shorter than the others, on each segment (Pl. IV, fig. 1). There are two or three hairs in the postero-lateral angle of each segment, one, then two, of these hairs getting progressively longer from the anterior to the posterior end of the abdomen. Last segment of female with entire posterior margin and few hairs.

Male.—Length, 1·54 mm.; width, ·54 mm. Last segment of abdomen with a small rounded projection at middle of posterior margin, and with numerous short spiny hairs on each side of this swelling; one specially strong, spine-like, but short hair on each lateral margin of the swelling. Ground colour of whole abdomen pale translucent yellowish brown; the male genitalia usually showing through, dark brown in colour (Pl. IV, fig. 5).

Linognathus forficula, sp. n. (Pl. IV, figs. 2, 4).

Many females from a reed-buck (*Cervicapra arundinum*), George's, Marimba District, Nyasaland (*Dr. E. H. Allon Pask*).

This curious new *Linognathus* is readily distinguished from any other species, so far included in the genus, by the conspicuous forceps-like pair of curved, pointed, posteriorly projecting, abdominal processes of the female. It is most nearly resembled by *L. brevicornis* and *L. tibialis* from antelopes, each of which has an emarginated posterior abdominal border, producing two short obtuse projecting processes, but these processes are not of the forceps-like character which is so pronounced in the new species.

Female.—Length, 2·34 mm.; width, ·74 mm. A striking species with plump whitish long abdomen and pale brown short thorax and head. *Head* with large thick-jointed brown antennæ inserted in front of the middle, and with anterior end of head strongly chitinized. But few short hairs on dorsal surface of head and one pair of soft longish ones arising near the postero-lateral margins, which margins are bordered with a strongly chitinized dark brown band. *Thorax* short, broad, with diverging lateral margins and bearing one pair of strong longish hairs and several minute hairs on the dorsal surface. Entire thorax brownish, because of strong broad diagonal bands that practically cover the dorsal surface. Legs brown, except at sutures which are whitish. *Abdomen* a little more than twice as long as wide, whitish, except last segment which is brown, with numerous rather longish hairs arranged segmentally in short transverse series on the dorsal surface, each series only extending across the median half of the segment. Two long conspicuous hairs in each postero-lateral angle of the two penultimate segments, and many shorter hairs on the lateral margins of the last forcipated segment. The forceps is made by a deep emargination of the posterior border of the last segment, which emargination, *i.e.*, the inner margin of the forceps, is also lined with short hairs. On the ventral aspect of the posterior end of the abdomen there is a curious, bluntly two-pointed process (Pl. IV, fig. 4).

Mallophaga.

Trichochetes climax, Nitzsch.

Numerous specimens from goats, Ilesha, Southern Nigeria, W. Africa (*J. J. Simpson*).

Nirmus fuscus, Nitzsch.

Several specimens from an unknown species of owl, Malachal, Egyptian Sudan (*H. H. King*).

Nirmus varius, Nitzsch (Plate V, figs. 5, 5*a*).

One female from a white-necked raven (*Corvultur albicollis*), Oshogbo, Southern Nigeria (*J. J. Simpson*), and an immature specimen from a starling, Malachal, Egyptian Sudan (*H. H. King*). As Piaget has figured only the head of this striking form we have given an illustration of the whole insect, showing the genital blotch (Pl. V, fig. 5*a*).

Nirmus vulgatus, Kellogg.

Numerous specimens from the starling and one from an owl, Malachal, Egyptian Sudan (*H. H. King*). This is the first record of this American species, which is found widely distributed on American passerine birds, from a host in the Old World.

Coniocotes gigas, Taschenberg.

Two males and a female from a guinea fowl (*Numida mitrata* ?), Azzar, near Bor, Egyptian Sudan (*H. H. King*).

Goniocotes aegypticus, sp. n. (Pl. V, figs. 2, 2*a*).

One female from a blue pigeon, Malachal, Egyptian Sudan (*H. H. King*). Resembles Piaget's *G. major*, but differs in the hairs of the abdomen, last segment of the abdomen in the female, &c. It also resembles Taschenberg's *G. procerus*, but differs from it in about the same particulars and also in the shape of the abdomen, which is broader than in *G. procerus*.

Female.—Length, 2·3 mm.; width, 1·8 mm.; light yellowish brown, with dark red-brown markings. *Head*: length, ·6 mm.; width, ·8 mm.; broad, conical, front rounded, with five short prickles on either side. Marginal frontal band yellowish brown, a little darker than ground-colour of head, turning inward just before the antennæ and ending in a red-brown blotch. Antennæ short; length of segments diminishing towards the end; a hair on the dorsal surface near the base of the antennæ. Eye with a short prickle. A marginal band extending around the temples and occiput, with colour little different from the ground-colour of head, except around the eye, where there is a red-brown blotch, and on the sinuous occiput which is also red-brown. Angles of temples acute, protruding, with two long hairs and one shorter one arising from a large curious projecting pustule (Pl. V, fig. 2*a*); also a minute prickle between the two long hairs. *Thorax*: length, ·5 mm.; width, ·7 mm.; with red-brown marginal bands. Prothorax trapezoidal: sides straight, diverging; a long hair in the posterior angles; posterior margin straight. Metathorax with lateral margins convex; two long hairs set close together arising from the central lateral angle. Posterior margin angled on abdomen, angle rounded, obtuse. A hair on each side of posterior marginal angle and another on the surface about midway between the meson and the lateral margin. The coxal bands distinct. *Abdomen* elliptical; last segment divided. Long hairs in the posterior lateral angles and two hairs on each side of all the segments, except the last, arising midway between the meson and lateral margins; median hairs apparently lacking on all but sixth and seventh segments.

Akidoproctus stenopygus, Nitzsch (Pl. V, figs. 6, 6*a*, 6*b*).

Three female specimens of this pale form from the spurwing goose (*Plectropterus gambensis*), Khor Felos, Egyptian Sudan (*H. H. King*). We figure this form owing to the fact that the only female heretofore known was headless. Taschenberg is of the opinion that this species is identical with *A. maximus*,

Piaget. This is owing to the fact that he considered his specimens as immature and that they had not as yet developed abdominal blotches. Our specimens, however, which are without question mature, show this to be a distinct species.

Lipeurus baculus, Nitzsch.

Two specimens from a blue pigeon, Malachal, Egyptian Sudan (*H. H. King*).

Lipeurus gambensis, Piaget.

A number of specimens, male and female, of this striking form from the spurwing goose (*Plectropterus gambensis*), Khor Felos, Egyptian Sudan (*H. H. King*).

Colpocephalum flavescens, Nitzsch.

Several specimens of this well marked species from a vulture, Oshogbo, Southern Nigeria (*J. J. Simpson*).

Colpocephalum semicinctum, Rudow.

A number of specimens, both sexes, from a white-necked raven (*Corvultur albicollis*), Oshogbo, Southern Nigeria (*J. J. Simpson*).

Colpocephalum sjoestedti, Kellogg.

One female from a spotted rat, Kyetume, by Kampala, Uganda (*Dr. R. van Someren*). This host of course is not normal and shows straggling. Also another *Colpocephalum*, species not determined, was recorded from the spotted rat. This is also, probably, a straggler.

Menopon mesoleucum, Nitzsch (?).

One specimen from an owl and one from a starling, Malachal, Egyptian Sudan (*H. H. King*).

Menopon pallidum, Nitzsch.

Several specimens from a chicken, Meko, Southern Nigeria (*J. J. Simpson*).

Menopon spinosum, Piaget.

A male and a female from a starling, Malachal, Egyptian Sudan (*H. H. King*).

Menopon africanum, sp. n. (Pl. V, fig. 3).

Three adult female specimens and one immature, from the spurwing goose (*Plectropterus gambensis*), Khor Felos, Egyptian Sudan (*H. H. King*). This species is unlike any of the few Menopons so far found on geese or raptorial birds.

Female.—Length, 1·8 mm.; width, ·8 mm.; light yellowish brown, with chestnut markings on head. *Head*: length, ·38 mm.: margin entire, with very shallow lateral depressions. Front rounded, with nine hairs on each side in front of the slight lateral depressions, one pair of which, arising just before the depression, is quite long. Mandibles prominent. Small chestnut ocular blotches, and two rather long hairs arising on the surface near these blotches. Other shorter hairs occur on the surface of the head, one arising from each of the prominent black ocular flecks. Temples rounded, bearing numerous hairs, three of which are particularly long. Occiput concave with two rounded chestnut blotches; occipital bands faintly discernible in one specimen. *Thorax*: length, ·36 mm.: width, ·52 mm.: pro- and meta-thorax about equal. Lateral and posterior margins of prothorax rounded, with but slight lateral posterior angles: a series of 18 stout spiny hairs on the lateral posterior margin, there being alternately a short one and then a long one. Metathorax with sides broadly diverging: a series of hairs, alternating in size, across the posterior margin: narrow lateral marginal bands. Legs with marginal bands on femur and tibia. *Abdomen*, elliptical: last segment as wide as the metathorax, rounded: series of hairs across each segment, alternating in size as on the thorax: longer hairs in the posterior angles of the segments: narrow marginal band on all except last segment with transverse blotches faint or lacking, at least on the dorsal surface.

Menopon antennatum, sp. n. (Pl. V, figs. 1, 1*a*, 1*b*).

Numerous specimens, both male and female, from the Guinea fowl (*Numida mitrata*), Azzar, near Bor, Egyptian Sudan (*H. H. King*). A small compact species with long slender antennæ. Entire insect of a dark golden brown colour, with no special markings and well clothed with hairs.

Female.—The sexes differ in size and shape of abdomen, that of the female being somewhat elongate and elliptical: length, 1·3 mm.: width, ·68 mm. *Head*: length, ·3 mm.: width, ·42 mm.; uniform dark golden brown in colour, almost hemispherical in shape. Front rounded, with numerous long hairs as shown in the figure: temples narrow, protruding, with angles rounded: occiput concave with a narrow, darker marginal band: many long hairs on the temples and on the surface of the head. Antennæ long and slender (fig. 1*b*): fourth segment as long as the other three: third segment tapering: second segment about as long as the third but broader: first segment shortest. *Thorax*: length, ·22 mm.; width, ·44 mm. Prothorax with the colour slightly lighter in the centre; sides rounded, continuous with the convexly rounded posterior margin, bearing a series of about 36 long hairs arising from small pustules. Metathorax appearing like the first segment of the abdomen; three short stout spines on the broadly diverging sides; a series of long hairs on the posterior margin. Legs small, lighter in colour than rest of body. *Abdomen*: length, ·8 mm.; width, ·68 mm.; elliptical, almost uniform in colour, which is dark golden yellow; long hairs on the lateral margins of each segment near the middle; a series of from 20 to over 40 long hairs across the middle of each segment; eighth segment much wider than the others, with two rows of hairs; last segment ending in an angle.

Male.—Length, 1·1 mm.; width, ·64 mm.; abdomen, length, ·6 mm., width, ·64 mm., appearing almost circular; last segment with arrangement of hairs and genitalia shown in fig. 1*a*; genitalia not strongly chitinized.

Menopon nigrum, sp. n. (Pl. V, figs. 4, 4*a*, 4*b*).

Four specimens, two male and two female, of this strongly marked species, from a white-necked raven (*Corvultur albicollis*), Oshogbo, Southern Nigeria (*J. J. Simpson*). This form is closely related to others of the genus found on crows, especially to *M. mesoleucum*, Nitzsch, and to *M. picæ*, Denny. It differs, however, from the former in its abdominal markings, pustulated abdominal hairs, form of head, &c., and from the latter in the arrangement of its hairs and in other details.

Female (Pl. V, fig. 4).—Length, 1·92 mm.; width, ·76 mm. *Head*: length, ·46 mm.; width, ·64 mm.; front rounded, with rounded angles on the sides; ten hairs on each side, some of which are minute, and one very long one arising on the margin at the angle near the base of the antennæ. Eye prominent, emarginate, with a distinct black fleck. Antennal band broad, pitchy, extending to meet the lighter coloured occipital bands which are united at their anterior ends, and also extending forward and ending in a pitchy blotch on the margin. Temples broad, squarish, with a pitchy marginal band extending around the concave occiput; four very long hairs on the temples arising from large clear pustules; also several shorter hairs. *Thorax*: length, ·46 mm.; width, ·64 mm. Prothorax lenticular, rounded behind, with no marginal bands; series of hairs across posterior margin. Mesothorax distinct, with pitchy marginal band extending around to anterior margin. Metathorax also with pitchy marginal bands; posterior margin convex, rounded; sides of meso- and meta-thorax diverging. Legs with broad femora, with pitchy marginal bands on femora and tibiæ. *Abdomen* elliptical; posterior margin of first segment convex, much enlarging that segment as is often the case in species of this group of the genus. Ground-colour rather dark, with a narrow pitchy lateral band and a dark chestnut transverse blotch extending across each segment. A series of hairs across each segment, arising from small clear pustules; very long hairs arising from the angles of the segments. On the under side of the first segment occurs a structure found in other members of this crow-infesting group, namely, two groups of short, stout spines as shown in fig. 4*b*.

Male.—Length, 1·76 mm.; width, ·62 mm.; the genitalia are strongly chitinized (fig. 4*a*); there is no fringe of hairs on the last segment, which is chitinized on its posterior margin.

Trinoton luridum, Nitzsch.

Two specimens of this common parasite of ducks and geese from the spurwing goose (*Plectropterus gambensis*), Khor Felos, Egyptian Sudan (*H. H. King*).

Rhynchota.

Eoctenes eknomicus, Kellogg and Paine.

In addition to the Anoplura and Mallophaga this collection contained also two males and one female specimen of a new species of Polyctenidæ (sub-order Hemiptera) taken from an unidentified bat from Khartoum, in the Egyptian Sudan (*H. H. King*). We have already described and figured this interesting parasite in the Entomological News (Philadelphia), vol. 21, pp. 401–403, pl. XIII.

EXPLANATION OF PLATE IV.

Fig. 1. *Linognathus africanus*, n. sp. ♀.

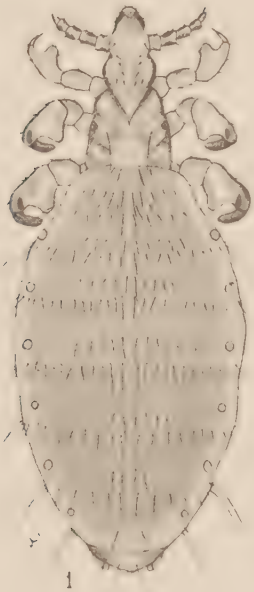
2. *Linognathus forficula*, n. sp. ♀.

3. *Hæmatopinus peristictus*, n. sp. ♀.

4. *Linognathus forficula;* ventral surface of last segments, ♀.

5. *Linognathus africanus;* last segments of ♂.

6. *Hæmatopinus peristictus;* last segments of ♂.

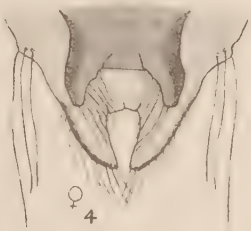


1

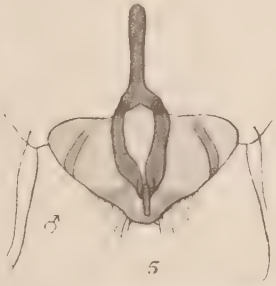
2

♀

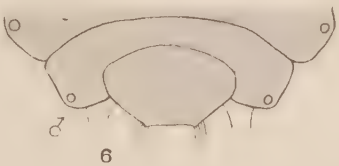
3



♀ 4



♂ 5



♂ 6

J. H. Paine *ad nat. del.*

AFRICAN ANOPLURA.

EXPLANATION OF PLATE V.

Fig. 1. *Menopon antennatum*, sp. n. ♀.

1*a*. „ „ genitalia of ♂.

1*b*. „ „ antenna, ventral side.

2. *Goniocotes ægypticus*, sp. n. ♀.

2*a*. „ „ temple showing pustule and hairs.

3. *Menopon africanum*, sp. n. ♀.

4. *Menopon nigrum*, sp. n. ♀.

4*a*. „ „ genitalia of ♂.

4*b*. „ „ first ventral segment.

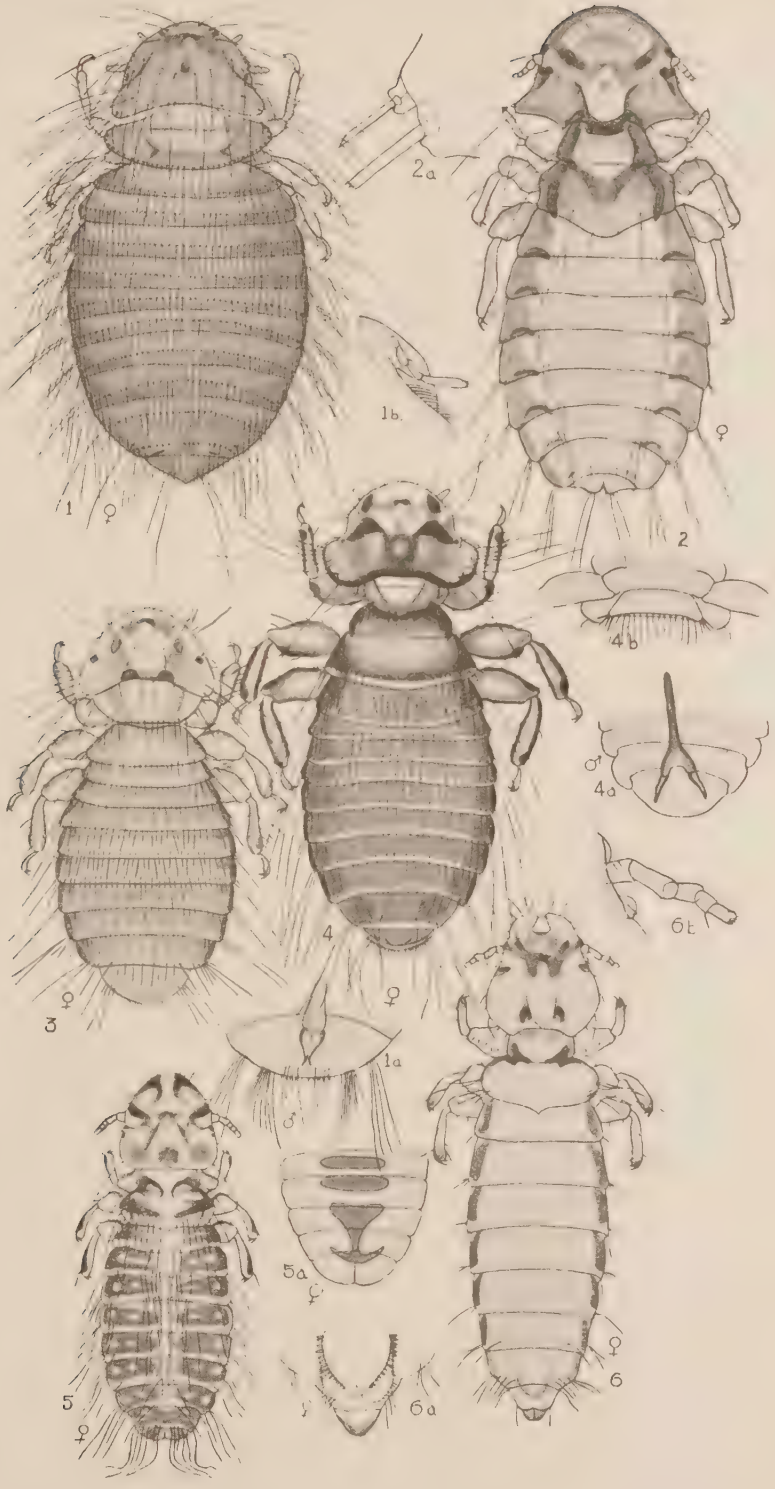
5. *Nirmus varius*, Nitzsch, ♀.

5*a*. „ „ genital blotch of ♀.

6. *Akidoproctus stenopygus*, Nitzsch, ♀.

6*a* „ „ last ventral segments.

6*b*. „ „ antenna of ♀ enlarged.



J. H. Paine *ad nat. del.*

AFRICAN MALLOPHAGA.

THE PHOTOGRAPHY OF DIPTERA.

By Dr. W. M. Graham,

Director of the Medical Research Institute, Lagos.

In the following article I have endeavoured to write as simply as possible a detailed account of the methods for photographing insects which I have myself found to be most successful, and no attempt has been made to discuss alternative methods.

Apparatus.

I make use of the following apparatus (fig. 1) :—

1. *A wooden base-board*, 36 inches long, 8½ inches broad, and 1 inch thick. Along this board travel two wooden platforms which can be clamped at any point. The upper half of each platform can be moved backwards and forwards upon the lower half by means of a rack and pinion, while the lower half is clamped to the base-board. The size of the platforms will depend upon the size of the

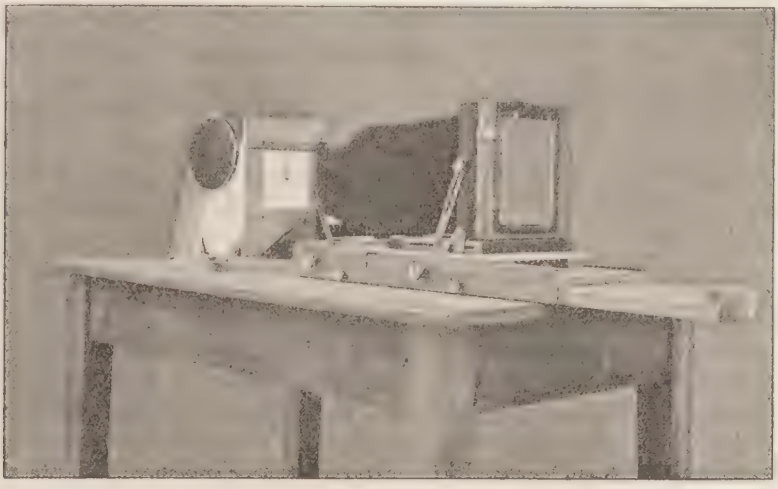


Fig. 1.—Photography of Diptera ; apparatus in position.

camera used. The back of the camera is placed upon one platform, the front of the camera upon the other, each part being securely fastened to the upper surface of its platform by bolt and thumbscrew, or otherwise. Thus the back or front of the camera attached to its platform can be moved independently to any point on the base-board and there clamped ; then by means of the racks and pinions each portion can be more accurately adjusted or focussed. At the front end of the base-board is erected perpendicularly a small *wooden easel* with a median opening of the size of a quarter-plate, at the top and bottom of

which are transverse grooved wooden slips to allow a glass plate to be inserted in front of the opening. The easel is clamped to the end of the base-board by a bolt and thumbscrew working in a transverse slot to allow the easel to be moved laterally for centring the picture horizontally on the ground-glass.

2. *The camera.*—A square-bellows, half-plate camera, to which a sufficient length of bellows has been added to give an extension of 36 inches. The camera should have a rising front for use in centring the picture vertically. A reversing back is often useful.

3. *The lens.*—A Zeiss microplanar lens of 100 mm. equivalent focus.

4. *The filter.*—A Wratten and Wainwright's K. III. yellow cemented filter, mounted as a lens-cap. This filter was placed upon the back of the lens, and all focussing was done with it in position. A similarly mounted red filter was occasionally found useful, to increase contrast.

5. *The glass support.*—The glass support to hold the object to be photographed was made as follows:—Take a sheet of glass (an old half-plate is suitable) and drill a very small hole through the middle. This hole should be small enough to be completely covered by the thorax of the insects to be photographed. Then cut a piece of cork to fit and cement it into the hole in the glass with Canada balsam in xylol. When the balsam is dry (24 to 48 hours), cut off the projecting cork level with the glass surface, and the support is ready for use.

6. *The millimetre scale.*—This scale is used in ascertaining the magnification of the image on the ground-glass. It is made by cutting off a couple of centimetres from any cardboard scale divided in millimetres. An excellent scale for this purpose will be found inside the cover of Messrs. Burroughs & Wellcome's Medical Diary. The piece of scale selected is cemented to a wooden rod by which it can be fixed above and in the same plane as the insect to be photographed.

7. *The mirrors.*—A small square mirror, 5 inches × 5 inches, for use in lighting the insect from below. An ordinary circular shaving mirror upon its stand, for use in lighting the insect from the side.

The relative position occupied by these seven parts of the apparatus is shown in the accompanying photographs.

8. *The plates.*—Wratten & Wainwright's panchromatic plates were found most satisfactory. The directions for development supplied by the makers were strictly followed. But when the temperature of the dark-room was above 80° F. the plate, after thorough fixing, was removed from the hypo. bath, well washed for 2 or 3 minutes, and then put into a 5 per cent. solution of formalin for 5 minutes to prevent frilling.

9. *The stop-clock.*—A Welborn Piper's photographer's stop-clock. The development was carried out in complete darkness, and a stop-clock was therefore necessary. The Welborn Piper clock can be set to strike, after the lapse of any number of seconds or minutes, and was found to be convenient and satisfactory.

10. *Exposure meter.*—A Watkins exposure meter of watch form was used, as it could be suspended from the top of the easel alongside the insect where its lighting resembled that of the insect to be photographed.

The Preparation of the Insects.

Insects to be photographed are best killed in a cyanide bottle, for not being rendered so stiff as those killed by chloroform vapour, they are more readily set, and require less handling. The most satisfactory preparations are those made from insects mounted immediately after being killed. Fairly satisfactory preparations can be made from dried unmounted specimens that have been thoroughly softened and relaxed by being placed upon damp sand in a closed vessel for a couple of days, but they require very much more skillful treatment than do freshly killed specimens.

Take a pin of suitable size (No. 20 for small, No. 7 for large Diptera), cut off the head and sharpen the cut end. Then take a suitable disc of 3-ply Bristol board and push the pin through the centre of the disc. Lay the dead insect upon its back upon a sheet of smooth paper and carefully insert the point of the pin into the thorax in the median line vertically and in such a position between the fore and mid coxae that the subsequent setting of the legs will not be obstructed. The pin is then kept perpendicular to the surface and carefully pushed into the insect until it touches the chitinous covering of the upper surface of the thorax, but it must not penetrate or mark this surface in any way. Care must be taken to insert the pin vertically and not to move the insect about upon the paper, as by so doing the surface of the thorax in contact with the paper would be denuded.

The disc with the insect now pinned upon it is raised from the table by means of the portion of the pin projecting from the cardboard, and the pin is gently drawn through the disc until the legs of the insect are in contact with the cardboard. The nearer the insect is drawn to the disc the easier will be the subsequent focussing, as the legs and body will be set more nearly in the same plane and less depth of focus will be required. If drawn too close the position of the legs will be unnatural and the effect bad. With each increase of magnification this becomes a more important matter.

Now lay the edge of the disc upon a sheet of cork and push a longer and stouter pin through the card near its periphery. The preparation is now mounted as a mosquito should be, and is fixed by means of the stout pin on a broad cork setting-board. Some minutes after its insertion the pin in the thorax becomes fixed by the drying of the exudation round it, and the further setting can be proceeded with. The wings are now gently and equally extended and retained in this position by being passed through loops of thick notepaper raised on pins to the height of the base of the wing. The legs are placed in a natural position and so as to display their distinctive marks, being retained in position by slips of thick note-paper or pins; and lastly, the position of the head and antennæ is corrected if necessary. The board with the insect upon it should be protected against the attack of ants, &c., by being placed in a creosoted box, and should be inspected daily so that readjustments, rendered necessary by the drying, may be effected while still possible. The insect should be allowed to dry sufficiently for both wings and legs to retain their positions after the paper supports have been removed. This usually requires some days, but photographing should not be too long delayed as the distortion and change of colour, induced by drying, may set in early and damage the specimen for picture-making.

As soon as the insect is sufficiently dry it is ready to be photographed, and for this purpose must be transferred from the disc of cardboard to the glass support already described. To do this, take the easel and introduce the glass support into the grooves so that the hole in the glass plate filled with cork is in the middle of the square opening in the easel. Then take a pin of the same size as that in the insect you are about to transfer from the cardboard disc and push it gently through the centre of the piece of cork cemented in the glass support. This will render easy the subsequent introduction of the sharpened end of the pin bearing the insect. Now remove the paper supports, take the disc bearing the insect between the fingers and thumb and gently push up the pin from beneath until it can be grasped by a curved forceps introduced between the insect and the disc. Holding the pin thus grasped in the forceps, draw off the disc, and introduce the sharpened end of the pin into the pinhole already made in the piece of cork in the glass support. Then from the back draw the pin through, until the legs of the insect are in contact with the glass plate, the head of the insect being so placed that it will be directed downwards when the easel is clamped in position on the base-board.

Now clamp the easel in position and arrange the millimetre scale above the insect, in the same vertical plane, and near enough to the insect to be included in the picture on the ground-glass. In the absence of the slide for the purpose, this can be effected by pushing a long pin through the wooden rod attached to the scale and pinning it to the wooden easel.

Illumination.

The lighting is effected in the following manner. The whole apparatus, arranged according to the above directions, is placed upon a table either in front of, and parallel with, a well lighted window, or in an open verandah where it will be sheltered from the wind. On the table behind the easel is placed a large reflector formed of a drawing-board with a sheet of white Bristol board pinned upon it (fig. 2). This reflector is to be inclined at such an angle as will secure uniform lighting of the whole of the opening in the easel. The amount of light from the reflector can be regulated by varying the distance of the reflector from the easel.

On the base-board, immediately in front of the easel, is placed a small square glass mirror (5″ by 5″) inclined at such an angle as will light the insect on the easel uniformly from below. Care should be taken that the reflection of the edge of this mirror is not included in the picture on the ground-glass, and that sharply defined clouds are not reflected.

On the table on the left-hand side of the base-board, and slightly in front of the easel, is placed a shaving mirror upon its stand. The mirror should be raised slightly above the head of the insect and inclined at such an angle as will secure the uniform lighting of the left side of the insect by light reflected from the mirror.

The object of the plate of glass, here used as a support, is to avoid the heavy shadows which would be cast by the body, legs and wings, of the insect upon an opaque support. The object of the white reflector behind the easel is to furnish

a background and to render the outlines of the insect distinct. If the light reflected by it be too strong the surface markings of the insect are rendered indistinct. The lighting from behind must therefore be completely subordinated to that from the front, supplied by the window and by the two mirrors. The object of the square mirror on the base-board is to light the head of the insect which, as already emphasised, should always be arranged upon the easel head downwards. The object of the side mirror is to light the side of the insect which would otherwise be in shadow.

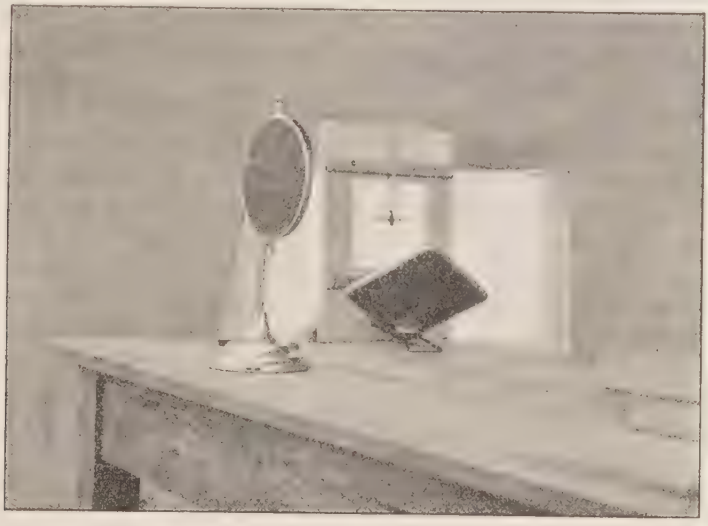


Fig. 2.—Arrangement of mirrors and reflector for illuminating the object to be photographed.

The more oblique the lighting the greater relief of the picture, but care is necessary to avoid reflections from shiny surfaces, especially in black insects. For the production of a successful negative the lighting must be so arranged that the outlines are sharp, and that as much relief is obtained as is possible without causing any reflections. If the lighting is correct the picture on the ground-glass will have these three qualities. If the details of the picture on the ground-glass be indistinct the lighting is wrong and requires alteration.

Magnification.

The insect is now ready to be photographed, and the amount of the magnification desired should be decided. This will depend upon the size of the picture, which will again be conditioned by the size of the plate employed. I have found quarter-plate a suitable size.

The amount of the magnification being decided upon, it only is necessary to place the front and back of the camera in correct relative positions. To do this it must be remembered that the distance from the lens to the insect must bear a

definite relation to the distance from the lens to the ground-glass. These focal distances are found as follows.

To find the distance between the lens and the insect.

Rule :—Divide the focal length of the lens by the amount of the magnification and add to the result one focal length.

Example :—Focal length of lens, 4 inches ; magnification, 2 (linear) :

$(4 \div 2) + 4 = 2 + 4 = 6$ inches.

To find the distance between the lens and the ground-glass.

Rule :—Multiply the focal length of the lens by the amount of the magnification and to the product add one focal length.

Example :—Focal length of lens, 4 inches ; magnification, 2 (linear) :

$(4 \times 2) + 4 = 8 + 4 = 12$ inches.

For a focal length of 4 inches and a magnification of 2, as in the above example, the lens should be 6 inches from the insect, and the ground-glass 12 inches from the lens. It will also be evident that to increase the magnification the lens must be moved nearer the insect, and the back of the camera moved further away from the lens.

Having placed the front and back of the camera approximately in their relative positions, the picture seen on the ground-glass should consist of an enlarged image of the insect, and below it an equally enlarged image of the millimetre scale. To every negative a free margin of at least half an inch should be allowed. This condition being fulfilled and the images carefully focussed, with the yellow screen in position behind the lens, the amount of the magnification should be ascertained in the following manner. With a pair of dividers measure upon the ground-glass five divisions of the magnified image of the millimetre scale and then find to how many divisions of an unmagnified millimetre scale those five divisions correspond.

Example :—5 divisions on the ground-glass scale equal 15 divisions of the unmagnified millimetre scale ; therefore the magnification is 3 times.

Now stop down the lens until enough depth of focus has been acquired to bring the body, legs and wings into sharp focus, and see that the picture is properly centred upon the ground-glass.

Exposure.

The length of exposure is proportional to the square of the distance of the image (on the ground-glass) from the lens. Now the greater the magnification the greater must be the extension of the camera, and therefore the longer the exposure that will be necessary. The relative exposures required for varying magnification can be found as follows :—

1. Find by means of an exposure meter the length of exposure required for a picture at the principal focus of the lens, *i.e.*, for a reproduction of natural size.

2. Decide upon the magnification desired.

3. At the chosen magnification, the exposure proportional to that required for an unmagnified picture, as found by the exposure meter, is given by the following formula :—(the magnification + 1)$^2 \div 4$.

Example.—It is required to magnify the insect 3 times ; thus

$$(3 + 1)^2 \div 4 = \tfrac{16}{4} = 4.$$

For a three-fold magnification of the image therefore an exposure of 4 times that found by the exposure meter for the unmagnified image will be required. Supposing then the exposure found by the meter were 2 seconds, the exposure for a three-fold magnification would require to be 8 seconds.

But besides the increased exposure needed for the magnification, the use of a yellow filter necessitates a still longer exposure. This factor varies with the nature of the filter and of the plate. It will be found printed upon a green label upon each box of panchromatic plates. For a K III filter it is about 5 times, but it varies slightly with different batches of plates, as will be observed upon the labels.

To find then the additional length of exposure necessitated by the use of the K III yellow filter, the exposure of 8 seconds as found above must be multiplied by the filter factor, which for a K III is about 5 times. Therefore $8 \times 5 = 40$ seconds, and this will be the exposure required in the above example.

All the necessary factors are included in the following formula, by which the exposure for any magnification under any conditions of light, aperture, &c., and with any filter can be calculated :—

$$\frac{(\text{the magnification} + 1)^2}{4} \times \text{exposure meter factor} \times \text{the filter factor.}$$

Development.

The use of a safe-light is without any advantage and unnecessary, as the plates can be best developed in complete darkness with the aid of a stop-clock that strikes the minutes. For development, the directions of the makers as regards solutions, temperature and duration should be followed. The density of the negative is a matter of some importance, as a denser negative is required to give a good print upon P.O.P. than is required to give a good print upon gas-light paper.

It is well therefore before beginning development to decide upon the type of negative required and set the clock accordingly. The time required for the production of 3 types of negative is given upon the card enclosed in each box of plates. The hypo dish should be placed in a box with a light-tight cover, so that as soon as the plate has been developed and placed in the hypo bath it may be covered and the light turned up. Otherwise the operator must sit in the dark until the plate is completely fixed.

Retouching.

In the case of a panchromatic plate used with a suitable fitter, retouching is not very often necessary. But in prints intended to be used for the production of half-tone blocks the details should be as sharp and as distinct as possible, as there is always a degradation of the definition in such reproduction.

In some cases then the retouching of the negative, if done judiciously by an entomologist, will so increase the distinctness of the leg and body markings of the insect, as to add materially to the accuracy of the half-tone reproduction. If injudiciously done the remedy is worse than the disease. In every case extraneous spots should be removed with the aid of a little retouching medium and a 4 H or 5 H lead pencil.

Printing.

Photographs of insects to be effective should be printed upon a glossy paper, as when printed upon a rough paper much of the detail is lost. The choice then is between P.O.P. and glossy gaslight paper.

Gaslight paper, in my opinion, produces the more effective prints, but the makers of half-tone blocks seem greatly to prefer prints on P.O.P. for use in block-making. I have found glossy Gravura gaslight paper most suitable for these prints, as this paper permits the use of a dilute Farmer's Reducer after development to improve contrast and to remove friction marks.

I have found Ilford P.O.P. (white) most suitable for use in the tropics, as it resists the injurious action of solutions above 80 F. better than other papers I have tried for this purpose.

THREE NEW AFRICAN SPECIES OF THE GENUS CHRYSOPS (FAMILY TABANIDÆ).

By Ernest E. Austen.

(*Published by permission of the Trustees of the British Museum.*)

The following paper is the result of the study of material recently received by the Entomological Research Committee, by which the types of two of the species described below have been presented to the British Museum (Natural History): the type of *Chrysops centurionis* has been handed over to the National Collection by its discoverer, Captain A. D. Fraser, R.A.M.C.

Genus Chrysops, Meigen.

Chrysops magnifica, sp. n. (fig. 1).

♀—Length (5 specimens) 6·75 to 9 mm.; width of head 2·5 to 3 mm.; width of front at vertex 1 mm. to just over 1 mm.; length of wing 7 to 8·5 mm.

General coloration of dorsal surface of head and body chrome-yellow, saffron-yellow or cadmium-yellow, with dark markings as shown in fig.* 1.—*Head saffron-yellow or chrome-yellow, frontal callus and facial tubercle shining black, ocellar spot dull clove-brown: antennæ black, first joint not swollen: thorax black, dorsum on each side of middle line with a lateral and an admedian saffron-yellow or chrome-yellow, pollinose, longitudinal stripe, the yellow stripes on each side of the middle line confluent in front and behind; dorsum of abdomen cadmium-yellow or saffron-yellow, with a pair of black, longitudinal stripes, each composed, as shown in fig.* 1, *of a series of elongate blotches somewhat irregular in outline; wing-markings as shown in fig.* 1; *legs in normal specimens entirely black, except bases of first joints of middle and hind tarsi, which are faintly tinged with cinnamon.*

Head (except on ocellar spot, frontal callus, and facial tubercle) clothed with short, saffron-yellow or cadmium-yellow hair; *frontal callus* nearly twice as wide as deep; face with a single, median, *facial tubercle*, showing no trace of a division except (in certain specimens) a slight indentation in the centre of its upper margin; *palpi* greyish clove-brown or blackish, clothed on outer surface with chrome-yellow or saffron-yellow hair, terminal joint large, lanceolate; *antennæ* moderately stout, but first joint not incrassate and second joint not short, first and second joints clothed with short black hairs, which, on the inner and upper sides of the first joint are occasionally mixed with saffron-yellow hairs. *Thorax*: pleuræ each with a broad, saffron-yellow or chrome-yellow, pollinose stripe, including humeral callus on each side and running below root of wing to base of halter; a second and shorter stripe below the one just mentioned, and between middle coxa and root of wing; pectus partly covered with chrome-yellow or saffron-yellow pollen; *scutellum* saffron-yellow or chrome-yellow pollinose, clothed, like the saffron-yellow or chrome-yellow thoracic stripes already described,

* For names and illustrations of colours, *see* Ridgway, "A Nomenclature of Colors for Naturalists" (Boston: Little, Brown & Company, 1886).

with hair of same colour ; a small, clove-brown or blackish, median emargination (looking like the rounded termination of the centre dark stripe on the dorsum of the thorax) sometimes visible on the front edge of the scutellum. *Abdomen* : longitudinal stripes on dorsum widely separated from lateral margins, commencing at base beneath scutellum, where they are in contact, terminating just before reaching hind margin of sixth segment, and frequently interrupted on hind margins of fourth and fifth segments ; a vestige of the stripes sometimes visible in centre of seventh segment ; dorsum, except stripes on first four segments,

Fig. 1.—*Chrysops magnifica*, Austen. ♀. × 6.

clothed with short, bright, cadmium-yellow or saffron-yellow hair ; venter saffron-yellow, unicolorous, clothed with short, appressed hair of same colour. *Wings* : dark area clove-brown or blackish brown, as shown in fig. 1 commencing at base, including costal cells, extending diagonally across proximal portion of first and second basal cells, and occupying whole of distal portion of wing from level of origin of third longitudinal vein ; hind margin of infuscated distal extremity only very faintly lighter than elsewhere ; distal portion of axillary cell slightly infuscated ; stigma clove-brown. *Squamæ* blackish. *Halteres* clove-brown, base of stalk lighter. *Legs* : tibiæ not incrassate, hind tibiæ fringed on inner and outer sides with fine black hair.

German East Africa : type and six other specimens from South Usagara, 22, 23. XII. 1910 (*S. A. Neave*).

Chrysops magnifica, which presents a certain superficial resemblance to *C. bicolor*, Cordier*—especially when the wings are in the resting position so

* Syn. *C. nigriflava*, Austen : *cf.* E. E. Austen, "Illustrations of African Blood-Sucking Flies," p. 48, Plate II, Fig. 14 (1909). *C. bicolor* also occurs in German East Africa (Usambara).

that the abdomen is partly concealed,—may be distinguished from that species *inter alia* by the first joint of the antennæ not being swollen; by the scutellum being without a large, black, median spot, extending from the base nearly to the hind margin; by the black abdominal stripes being less deep in colour, less solid in appearance, much more slender, and separated by an interspace the width of which on the third segment is as great as or greater than the width of each stripe; by the stripes being widely distant from the lateral margins, instead of in contact therewith from the third segment onwards; and by the infuscated distal extremity of the wing having only a barely perceptible lightening on the hind border, instead of there being, as in the wing of *C. bicolor*, a distinct paler area extending from the posterior distal portion of the second submarginal cell into the fifth posterior cell.

From *Chrysops neavei*, Austen* (the type and only specimen of which at present known was obtained in the Katanga District, Congo Free State), in which the thorax is somewhat similarly marked, while the abdomen exhibits a pair of incomplete, longitudinal, clove-brown stripes,—the new species may at once be distinguished *inter alia* by the antennæ, palpi, and legs being black or blackish, instead of tawny-ochraceous, ochraceous-buff, ochraceous, or mummy-brown.

The exceedingly handsome species described above cannot possibly be confused with any other African species of *Chrysops* yet discovered.

Chrysops magnifica var. **inornata**, var. n.

♀.—Length (1 specimen) 8·5 mm.

Distinguished from the typical form of the species by the almost total absence of abdominal markings, and by the somewhat greater depth of the dark interspace between the lateral yellow stripe on the dorsum of the thorax and the yellow stripe on the pleura.

Thorax: admedian, chrome-yellow stripes on dorsum somewhat narrower than in typical form; *scutellum* with a small, median, semicircular clove-brown spot on front margin. *Abdomen:* black markings on dorsum confined to a narrow, median blotch on first segment (just beyond distal extremity of scutellum), a pair of quadrate, admedian spots on sixth segment, extending from front nearly to hind margin, and a transverse band on seventh segment, not reaching lateral margins. *Wings:* hyaline portion somewhat less clear than in typical form, having a faint, ochraceous tinge.

In all other details agreeing with typical form of C. magnifica, *as described above.*

Nyasaland Protectorate: Zomba (Nkanda), December, 1910 (*Dr. H. S. Stannus*).

In view of the total absence of structural differences, and the complete agreement of the wing-markings, it seems advisable—in spite of the remarkable difference in the appearance of the abdomen (due to the black stripes being almost entirely wanting),—to regard this form, provisionally at any rate, as a variety or local race of *Chrysops magnifica*, rather than as a distinct species.

* *Cf.* Bull. Ent. Res., Vol. I, Part 4, pp. 275–277 (January, 1911).

Chrysops centurionis, sp. n. (fig. 2).

♀.—Length (2 specimens) 9·5 to 10·6 mm.; width of head 3 to 3·25 mm.; width of front at vertex 1·2 mm.; length of wing 9·75 to 10·25 mm.

Large-sized, long-winged species; dorsum of thorax and distal extremity of abdomen mummy-brown, proximal portion of abdomen raw-sienna-coloured, with a pair of broad but semi-indistinct, blackish, longitudinal stripes; antennæ dark brown (second joint clove-brown), first joint, except distal extremity, russet-brown or cinnamon; wings marked as shown in fig. 2, without a broad and conspicuous blackish or dark brown transverse band across centre; legs burnt-umber or raw-umber-coloured, front and hind tibiæ and first joint of front tarsi brown, last four joints of front tarsi and distal extremities of middle and hind tarsi dark brown.

Fig. 2.—*Chrysops centurionis*, Austen. ♀. × 5.

Head ochre-yellow pollinose, a transverse band on vertex, including ocelli and extending from eye to eye, dark sepia-coloured; *frontal callus* raw-umber-coloured, dark brown on sides and upper margin, wider than deep, upper margin curved and produced in centre into a small upwardly directed angle, lower margin straight; face with a single, median, shining mummy-brown, elongate cordate *facial tubercle*; jowls with a small, shining, clove-brown transverse mark, somewhat triangular in outline, below each eye; front, above frontal callus, clothed with short dark brown hair, under surface of head and sides of lower part of face clothed with chrome-yellow hair; *palpi* tawny-ochraceous, terminal joint lanceolate, narrower than in foregoing species; first joint of *antennæ* not at all swollen, clothed like second joint with short black hair, third joint at end of proximal third with a burnt-umber-coloured band. *Thorax*: dorsum with a narrow, dark brown, longitudinal median stripe, and also with a pair of more or less faint and indistinct chrome-yellow or buff-yellow, admedian pollinose

stripes, which, starting from front margin, disappear on or shortly before reaching transverse suture, and are again visible close to posterior margin, where they curve round on to the postalar calli; lateral borders of dorsum and distal two-thirds or three-fourths of *scutellum* clothed with chrome-yellow pollen and short, bright hair of same colour; pleuræ and pectus clove-brown, thinly clothed with yellowish-olivaceous pollen except between and above front coxæ, on upper border of mesopleuræ, on metapleuræ and upper posterior angles of hypopleuræ, and on posterior angles and hind margin of sternopleuræ, where ground colour is concealed by patches of Naples-yellow pollen and bright, chrome-yellow hair; base of *scutellum* mummy-brown. *Abdomen*: blackish longitudinal stripes on dorsum, as shown in fig. 2, extending from middle of first to or nearly to middle of third segment, most distinct when abdomen is viewed at a low angle from in front or behind; when abdomen is viewed vertically from above the stripes appear very faint, though, as shown in the figure, each stripe includes a distinct clove-brown blotch on the first segment, and also a smaller, similarly coloured fleck near the hind margin of the second segment; on first segment, in middle line and in contact with hind margin, is a minute and inconspicuous, dark brown spot; except on the blackish stripes, which are clothed with minute black hairs, the dorsum is covered with minute, appressed, ochre-yellow hairs in the case of the first and second segments, and with similar ochraceous hairs in that of the third and fourth segments; remaining segments clothed with minute, dark brown hairs; sides of first two segments clothed with finer and longer, pale yellow hairs; lateral margin of dorsal scute of second segment occupied by a clove-brown, longitudinal stripe, which is sometimes prolonged at least to middle of third segment; venter clothed with minute, appressed, ochraceous or ochre-yellow hairs, and similar to dorsum as regards ground colour, but without a trace of longitudinal stripes, though third and fourth segments sometimes each with a dark brown, median blotch. *Wings*: costal cells and an oblique area (paler in first submarginal cell) beyond oblique dark brown mark extending from stigma to posterior branch of fifth longitudinal vein (*see* fig. 2) raw-sienna-coloured; apex of wing occupied by a fairly dark, sepia-coloured band, commencing on costal border just beyond stigma, filling approximately the distal fourth of the wing, and extending back along hind border into fifth posterior cell, which it entirely fills; main stem and fork of fifth longitudinal vein suffused with dark brown; stigma dark mummy-brown. *Squamæ* blackish. *Halteres* clove-brown, base of stalk paler. *Legs:* middle and hind coxæ clove-brown, hind femora more or less brown on outer side, except at base; coxæ on outer side sparsely clothed with bright, ochre-yellow hairs, femora clothed chiefly with short, ochraceous hair, hairy covering of remainder of legs dark brown or brownish; front tibiæ moderately incrassate.

Uganda Protectorate: type and one other specimen (the latter presented by the Entomological Research Committee) from Buanuka, Chagwe, April, 1910 (*Captain A. D. Fraser, R.A.M.C.*).

The nearest known allies of *Chrysops centurionis* are *C. dimidiata*, v.d. Wulp, and *C. silacea*, Austen, to both of which the new species presents a general resemblance. From the former of these *C. centurionis*, while exhibiting a fairly

close agreement with it in the wing-markings, is distinguishable by its larger size, by the coloration of the median portion of the dorsum of the thorax being mummy-brown instead of greyish-olivaceous or blackish, and by the dark stripes on the abdomen being less deep in colour and not extending beyond the middle of the third segment. In comparison with *C. silacea* the distinctive characters of the new species are :—the browner coloration of the dorsum of the thorax, the incompleteness of the admedian, ochraceous, thoracic stripes, the ground colour of the dorsum of the abdomen, which is much less vivid, the greater breadth and faintness of the abdominal markings, the greater breadth and darker hue of the oblique transverse mark in the centre of the wing below the stigma, and the darker coloration of the legs, especially the hind femora and tibiæ.'

Chrysops cana, sp. n. (fig. 3).

♂.—Length (2 specimens) 7·5 mm. ; width of head 2·5 mm. ; width of front in centre 0·25 mm. ; length of wing 7·6 mm.

Small, partly grey, partly white species, with face and body thickly clothed with white hair, with black antennæ and legs, and with semi-hyaline wings conspicuously marked with clove-brown, as shown in fig. 3.

Head : face and jowls dull white, no shining tubercle or tubercles on former, occiput grey, hairy covering of face also extending on to jowls and lower surface ; upper two-thirds of front blackish slate-coloured, space between base of antennæ

Fig. 3.—*Chrysops cana*, Austen. ♂. × 6.

and eyes pearl-grey ; ocelligerous tubercle occupying vertex clothed with erect whitish hair in centre of posterior margin, and with erect blackish hair on posterior angles and in front ; *eyes* noticeably flattened in an antero-posterior direction, narrowly separated in centre of front* ; *palpi* slate-grey, relatively

* In a note attached to one of the two specimens of this species taken by him, the collector, Mr. S. A. Neave, describes the eyes in the living insect as :—" Deep blue green, with three small white spots near the outer margin."

large, and thickly clothed with white hair; first and second joints of *antennæ* and extreme base of third joint shining, remainder of third joint dull, first joint strongly swollen and clothed, except on distal extremity, with outstanding whitish hair, second joint (which is also relatively stout and rather short) and tip of first joint clothed with black hair. *Thorax* plumbeous, *scutellum* mouse-grey, entire thorax clothed with erect white hair. *Abdomen* milk-white: first segment with a large, median, clove-brown blotch, extending from base to hind margin but not reaching posterior angles; basal angles of first segment, an elongate, quadrate, median blotch on second segment, extending from base and occupying proximal three-fourths, and fourth and two following segments, except posterior angles and hind margins, cinereous; third segment also sometimes with a faint and ill-defined cinereous blotch in centre, beyond middle, and a somewhat more distinct blotch of similar colour on each lateral margin; *venter* (except posterior angles of first segment, lateral thirds and hind margin of second segment, and hind margins of four following segments) slate-grey, darkening more or less to clove-brown in middle line except near hind borders of segments; ventral scute of third segment sometimes with a pair of more or less ill-defined, cream-buff-coloured, admedian blotches; hairy covering of dorsum of abdomen shorter and more recumbent than that of thorax; ventral scutes of third and three following segments clothed with minute, appressed hairs. *Wings:* clove-brown area occupies extreme base (including proximal extremities of both basal cells), costal border to a point just short of apex of wing, and forms an equally sharply defined median transverse band, which includes extreme tips of both basal cells as well as stigma and portion of wing immediately beyond it; the transverse band reaches the hind margin of the wing only at the apex of the anal cell, since in the fourth and fifth posterior cells, except on the proximal border of the latter, it dies away (*see* fig. 3); beyond the clove-brown transverse band, and in contact with its distal margin, is a narrow milky band (visible when the wings are seen against a dark background), which indents the costal border, and extends across the wing as far as the point at which the distal margin of the clove-brown transverse band dies away. *Squamæ* clove-brown. *Halteres* clove-brown. *Legs*: front tibiæ very slightly swollen (somewhat flattened from side to side), hind tibiæ distinctly swollen; coxæ grey, extreme base of front and middle tibiæ and proximal half (or less) of first joint of middle and hind tarsi more or less distinctly mummy-brown; coxæ and middle and hind femora, except distal extremities, clothed with white or whitish hair; legs elsewhere clothed with black hair, which is long and fine on posterior and postero-ventral surfaces of front femora, but otherwise short, except on inside and outside of hind tibiæ, on which it forms conspicuous fringes.

East Africa Protectorate: type and one other specimen from Masongoleni (Uganda Railway), alt. 3,000 ft., 29. III.—1. IV. 1911 (*S. A. Neave*).

Chrysops cana is evidently allied to *C. wellmanii*, Austen, which occurs in Angola and N.-W. and S. Rhodesia, and with which it agrees in the shape of the head and eyes, coloration of the face and facial hair, absence of a facial tubercle or facial tubercles, coloration of the thorax and its hairy covering, and in the wing-markings. Unfortunately the female of *C. cana* and the male of

C. wellmanii are still unknown, and it is consequently at present impossible to make a complete comparison of the two species, the latter of which, however, apart from less conspicuous characters, can at once be distinguished from *C. cana* by the general coloration of its abdomen, which is ochraceous-buff or tawny. The milk-white hue of the abdomen of *C. cana*, with its thick covering of white hair, will indeed distinguish the species from any other African *Chrysops* at present described.

While no information as to its habitat has yet been received, the remarkable coloration of the insect described and illustrated above would seem to indicate adaptation to existence in a sandy or desert region.

NEW AFRICAN HIPPOBOSCIDÆ.

By Ernest E. Austen.

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The types of the two species and of the variety described below are in the British Museum (Natural History).

Genus Hippobosca, Linn.

Hippobosca hirsuta, sp. n. (fig. 1, *a* and *b*).

♂ ♀.—Length, ♂ (3 specimens) 7 mm., ♀ (2 specimens, both gravid) 8 to 8·6 mm.; width of head (both sexes) 2·2 to 2·25 mm.; approximate greatest width of front in both sexes 1 mm.; length of wing, ♂ 7·5 to 7·8 mm., ♀ 8·2 mm.

Thorax chestnut, with, on dorsum, faint and somewhat reduced Naples-yellow markings of usual Hippobosca-*type* (see fig. 1, *a*), *scutellum however dark brown, with a large and very conspicuous, straw-yellow, median spot, shaped as shown in* fig. 1 *a*: *abdomen in dried specimens clove-brown, with the usual shining black callosities at posterior extremity*: *head, body and legs clothed with relatively long, pale, glistening, straw-yellow or yellowish-white hair, which on dorsum of thorax and on legs is rough, coarse, and almost erect*; *front legs ochraceous-rufous, middle and hind legs orange-rufous, extreme tips of middle and hind femora dark brown above.*

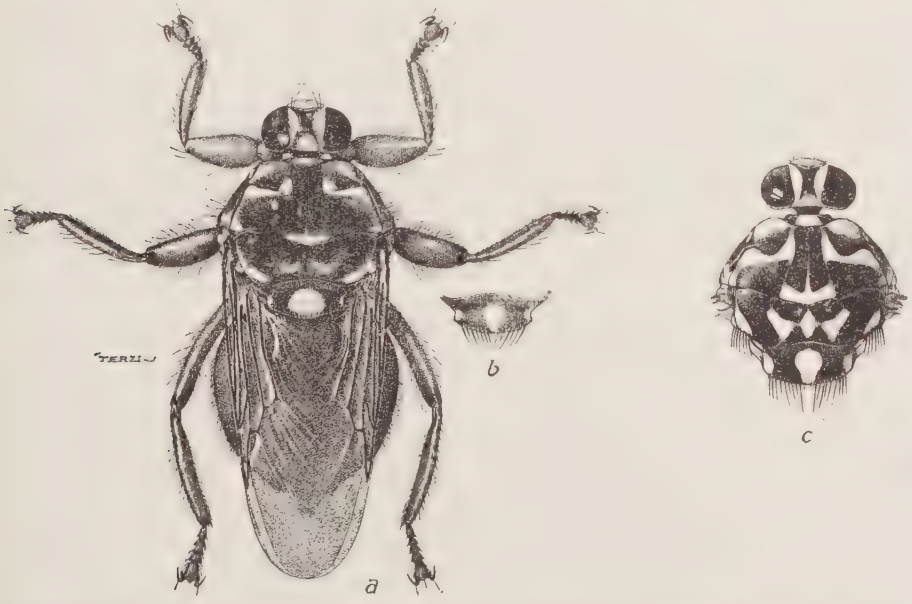

Fig. 1.—*a*, *Hippobosca hirsuta*, Austen. ♀. × 6. *b*, Scutellum of *Hippobosca hirsuta* var. *neavei*, Austen. × 6. *c*, Head and thorax of *Hippobosca maculata*, Leach. × 6.—From a specimen from Lorenço Marquez: to show differences between thoracic markings in this species and in *H. hirsuta*, Austen.

Head shining straw-yellow, sides of front shining buff-yellow, *frontal stripe* dull Vandyke-brown; *palpi* dark brown, clothed with hair of same colour and character as that on head itself; inner margins of sides of front fringed with long hair. *Thorax*: Naples-yellow markings on dorsum (except scutellum) of same kind as those exhibited by *Hippobosca maculata*, Leach, and *H. camelina*, Leach, but much less distinct and sharply defined; in front of transverse suture, transverse mark behind each humeral callus, though present, is usually less distinct than it appears in fig. 1 *a*, while in middle line, and resting on transverse suture, the lateral arms of the mark that in case of *H. maculata* resembles a cruciform sword-hilt are shortened and rounded off, much as they are in *H. camelina*; behind transverse suture the median rhomboid mark seen in *H. maculata* has disappeared, and the admedian marks, instead of having definite outlines, as is usually the case in *H. maculata*, are ill-defined and more or less indistinct (*cf. a* and *c*, fig. 1); basalangles of scutellum Naples-yellow; hair on pectus paler, finer, and denser than on dorsum. *Wings:* sepia-coloured, principal veins dark brown. *Legs*: last joint of middle and hind tarsi dark brown above; claws black.

Uganda Protectorate: type of ♂, type of ♀, and one other ♀ from Mohokya, Toro Plains, 14. III. 1911 (*Dr. R. A. L. Van Someren*); also 2 ♂♂ from the vicinity of the north-east shore of Lake Ruisamba (or Dweru), South Toro, 1910 (*Captain F. P. Mackie, I.M.S.*, per Colonel Sir David Bruce, C.B., A.M.S., F.R.S.).

All the foregoing specimens, as well as those enumerated below as belonging to a variety of *Hippobosca hirsuta*, were caught on Waterbucks (*Kobus defassa*, Rüppell), on which antelope this fly would consequently appear to be specially parasitic. Whether indeed it occurs on any other species of game cannot yet be stated. As regards the possibility of its playing a part in the dissemination of animal trypanosomiases, while prolonged experiments and observations will of course be needed in order to determine whether *H. hirsuta* ever acts as a disease-carrier if it should find its way on to domestic animals, it may be interesting to note that, when writing to the author from Toro, in February last, Dr. Van Someren mentioned that he had "infected a monkey with these fly caught on a Waterbuck, whose blood showed trypanosomes (? *T. pecorum*, Bruce)."

While evidently allied to *Hippobosca maculata*, Leach, reddish specimens of which it resembles in general appearance, *H. hirsuta*, in addition to the differences in the thoracic markings described and illustrated above, is distinguishable from that widely distributed species by the much greater width of its front and frontal stripe,* the hairiness of the dorsum of the thorax, and the absence of a dark brown, elongate patch on the inside of the distal extremity of the hind tibiæ. The infuscation of the distal extremities of the middle and hind femora in *H. maculata*, though often very extensive and much more so than the corresponding markings in the case of *H. hirsuta*, is subject to considerable individual variation, and cannot be relied upon as a distinctive character.

From *Hippobosca camelina*, Leach, *H. hirsuta*, apart from its smaller size, may be distinguished by the indistinctness of the post-sutural, admedian, thoracic

* These differences are unfortunately not brought out with sufficient clearness in the figures.

markings, the much greater hairiness of the dorsum of the thorax, and the greater coarseness and outstanding character of the hair on the hind femora.

Larva.—A larva of this species in the British Museum (Natural History), deposited by a ♀ taken by Dr. Van Someren at Mohokya, Toro, Uganda Protectorate, in February, 1911 (presented by the Entomological Research Committee), is of the usual *Hippobosca*-type, *i.e.*, ovoid or flattened globular in shape, and cream-buff in colour, with, at the narrower (posterior) extremity, a very conspicuous black cap, which exhibits two prominences separated by a broad vertical groove. The dimensions of this specimen are :—length 4 mm., greatest breadth, 3·5 mm.

Hippobosca hirsuta var. **neavei**, var. n.

♂ ♀.—Length, ♂ (6 specimens) 6 to 6·5 mm., ♀ (4 specimens) 6·75 mm. (non-gravid) to 9 mm. (gravid) ; width of head (both sexes) 2 mm. to 2·2 mm. ; width of front (both sexes) just under 1 mm. to 1 mm. : length of wing, ♂ 6·75 to 7·6 mm., ♀ 7·2 to 7·75.

Apart from being on the whole somewhat smaller in size, as indicated by the dimensions given above, agreeing in all essential respects except shape of median spot on scutellum, with typical form ; median spot on scutellum—instead of being large, rounded in front, and flattened behind—small and shaped as shown in Fig. 1, *b, that is, more or less triangular, with apex of triangle resting on hind margin.*

Head : anterior portion of plate on vertex usually brown or brownish. *Thorax : scutellum* on each side of median spot, except basal angles, generally ochraceous or ochraceous-buff rather than dark brown.

North-Eastern Rhodesia (Luangwa River Valley) : type of ♂, type of ♀, and two other ♂ ♂ from the junction of the Mpamadzi and Luangwa Rivers, 24. VIII. 1910 ; two ♂ ♂, two ♀ ♀ from the Upper Luangwa River, 3. VIII. 1910 ; one ♂, one ♀ from the Mid Luangwa River, 12. VIII. 1910 (*S. A. Neave* : presented by the Entomological Research Committee).

The whole of these specimens were taken on Waterbucks, and there seems no reason to consider them as representing anything more than a variety of the *Hippobosca* infesting the same animal in Uganda, which is here regarded as the typical form.

Genus Olfersia, Wied.

Olfersia dukei, sp. n.

♀.—Length (1 specimen) 7 mm. ; width of head 2 mm. ; width of front at vertex 1·4 mm. ; length of wing 9·4 mm.

General coloration black or clove-brown ; sides of front (frontal margins or parafrontals), plate on vertex, and dorsum of thorax (except humeral calli) shining black or blackish clove-brown ; abdomen, dorsal surfaces of middle and hind legs, and dorsal surface of front femora clove-brown ; anterior two-thirds of inner borders of sides of front clothed with fairly long yellowish hair, with as usual a single longer black hair in front and behind ; wings sepia-coloured.

Head : shining plate on vertex transversely elongate, anterior angles rounded off, length of hind margin at least two and a half times as great as depth of plate

from front to rear; frontal stripe (in dried specimen) clove-brown; face raw-umber-coloured in centre, dark brown on each side below; jowls and under surface of head on each side mummy-brown, central area of under surface of head ochraceous buff; under surface of head clothed with bright, ochre-yellow hair; *palpi* relatively rather narrow (from above downwards) and elongate, their outer surfaces dark brown or clove-brown, and clothed with brownish hair; visible portion of *antennæ* shining dark brown, clothed with black hair. *Thorax:* humeral calli raw-umber-coloured, dark brown behind, clothed above with black mixed with ochre-yellow hairs; portion of dorsum immediately behind humeral calli, and in front of transverse suture, clothed with appressed, ochre-yellow hairs; hind margin of scutellum and portion of thorax immediately in front of scutellum also clothed with ochre-yellow hairs; pleuræ blackish and clothed with similarly-coloured hair; pectus raw-umber-coloured. *Abdomen* clothed for most part with black hair. *Wings:* principal veins and thicker portions of veins clove-brown or dark brown. *Legs:* front tibiæ and tarsi, and under surface of front femora (in dried specimen at any rate) more or less raw-umber-coloured; under surfaces of middle and hind femora and tibiæ (in dried specimen) more or less mummy-brown; legs clothed for most part with black or blackish hair; claws black.

Uganda Protectorate: Nsadzi Island, Lake Victoria, 23. I. 1911, on fish eagle, *Haliaëtus vocifer*, Daud. (*Dr. H. L. Duke*).

Although closely allied to and resembling *Olfersia* (*Ornithomyia*) *intertropica*, Walk.,* the species described above is distinguishable by its more elongate and darker palpi, by the hairs and punctures on the inner borders of the sides of the front being fewer in number and coarser, and especially by the different shape of the shining plate on the vertex, which is more transversely elongate, and the anterior angles of which are more abruptly rounded off.

Dr. Duke, in whose honour the species is named, states that he met with two specimens of *O. dukei* on a fish eagle shot by him at the water's edge. The type specimen was moving about under the feathers; the other, which was not caught, flew round the dead bird, settled several times on Dr. Duke, and ran under his coat, but did not bite him. It flew like a Tsetse, settled abruptly, and followed for some fifty yards.

* *O. intertropica*, Walk., is a widely distributed species which, in the Sandwich Is. at any rate, is parasitic on the short-eared owl: it has not been recorded from Africa, but, besides occurring in the Sandwich Is., is also found in Mexico and Brazil. As stated elsewhere by the present writer (*cf.* Ann. and Mag. Nat. Hist., Ser. 7, Vol. xii, p. 264, 1903), *Olfersia acarta*, Speiser, is apparently a synonym of this species.

TWO NEW SPECIES OF TABANUS FROM THE ANGLO-EGYPTIAN SUDAN.

By Ernest E. Austen.

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The types of the species described below have been presented to the British Museum (Natural History) by Mr. H. H. King, Government Entomologist, Anglo-Egyptian Sudan, by whom coloured figures of both species will shortly be published in the forthcoming Fourth Report of the Wellcome Tropical Research Laboratories, Khartoum.

Genus Tabanus, Linn.

Tabanus camelarius, sp. n.

♂ ♀.—Length, ♂ (1 specimen) 12·5 mm., ♀ (2 specimens) 11·6 to 12·8 mm.; width of head, ♂ 4·25 mm., ♀ 3·75 to just under 4 mm.; width of front of ♀ at vertex 0·6 mm.; length of wing, ♂ 8·75 mm., ♀ 8·25 to 8·4 mm.

Somewhat narrow-bodied, elongate species; dorsum of thorax mouse-grey in ♂, blackish slate-coloured in ♀, and in both sexes longitudinally striped with light grey, though less distinctly in ♂ than in ♀; dorsum of abdomen dark brown in ♂, clove-brown or blackish brown in ♀, and in both sexes with three longitudinal stripes, which are smoke grey in ♂ and whitish grey in ♀; one stripe is median and continuous; midway between this and lateral margin on each side is a stripe, which is largely composed of disconnected, longitudinally elongate spots: venter light grey, with a broad, blackish, longitudinal stripe, interrupted on hind margins of segments and in ♀ very conspicuous, in ♂ much less distinct and inconspicuous unless viewed from behind; femora slate-grey, with a whitish grey bloom, tibiæ partly cream-buff, front tarsi entirely black, middle and hind tarsi blackish brown, except proximal two-thirds of first joints, which are cream-buff.*

Head: frontal triangle in ♂ drab-grey, crossed by an ill-defined brownish band on a level with and just below upper margin of lower third of eyes; front in ♀ grey (drab-grey between base of antennæ and frontal callus), clothed on upper half with minute black hairs; face and jowls whitish grey in both sexes and clothed with white hair, in ♀ an indistinct dusky mark between base of antenna and eye on each side; *eyes* in ♂ (dried specimen) with small facets (occupying lower third and posterior border) dark brown, and with the transversely fusiform area occupied by the large facets, which is divided medially by the junction of the eyes, drab above and on each side, and crossed horizontally by a curved, dark brown band, which does not reach the postero-lateral margins of the area, and below the admedian two-thirds of which the large facets are paler; eyes in ♀ (dried specimen) with two narrow, dark bands across centre; in ♀, *front* moderately broad (inner margins of eyes almost parallel, converging very slightly

* For names and illustrations of colours see Ridgway, "A Nomenclature of Colors for Naturalists" (Boston: Little, Brown & Company, 1886).

below), *frontal callus* clove-brown, shining, extending from eye to eye and nearly quadrate in shape, though slightly higher in middle line than at sides, in rubbed specimens connected in middle line above with a small black spot in centre of front, above which and not connected with it is a second and much smaller, quadrate, median, blackish spot near vertex ; *palpi* in both sexes cream-coloured, terminal joint in ♂ pyriform, clothed with whitish hairs and also on lower portion of distal two-thirds of outer surface with black hairs ; terminal joint of palpi in ♀ swollen above and ending in a sharp point below, clothed on outer surface with minute black hairs, mixed with minute whitish or yellowish white hairs ; first and second joints of *antennæ* in both sexes isabella-coloured, clothed with minute black hairs, third joint in ♂ narrow and elongate, its proximal portion cinnamon, its terminal annuli brown ; expanded portion of third joint in ♀ moderately broad and more or less russet-brown, terminal annuli dark brown or clove-brown. *Thorax* : dorsum in ♂ thinly clothed with erect brownish or blackish hair, mixed with yellowish hairs on central third in front of transverse suture ; dorsum in ♀ thinly clothed with appressed yellowish hairs, especially on central third and in front of suture ; the grey stripes on dorsum consist in both sexes of a narrow median line extending from front margin to transverse suture, a broader and complete stripe on each side of this, midway between middle line and lateral margin, and a still broader stripe on each lateral margin, which includes the humeral and extends to the postalar callus ; postalar calli and region immediately above base of each wing clothed with whitish hairs ; from humeral callus to base of wing on each side runs a narrow, dark brown, horizontal stripe, which is clothed with dark brown or black hair : pleuræ and pectus light grey, and clothed in both sexes with white hair : scutellum agreeing in ground colour of its upper surface with that of remainder of dorsum, grey on lateral and hind border, in ♂ thinly clothed above with erect brownish hairs, mixed with appressed yellowish hairs near front margin, and with whitish hair on lateral and hind border, in ♀ clothed above with appressed yellowish hairs mixed with some more erect blackish hairs. *Abdomen* : median grey stripe on dorsum extending from base to hind margin of sixth segment, and clothed with, minute, appressed, yellowish hairs ; grey stripe between median stripe and lateral margin on each side broken up into spots after second segment, and terminating, like median stripe, on sixth segment, although in ♂ (at least in case of type) the spots on fifth and sixth segments are invisible unless abdomen be viewed at a low angle from behind ; the spots on the third and following segments forming the paired stripes situated more or less close to or even in contact with the front margins of the segments, but widely separated from the hind margins ; lateral borders of first six segments grey, posterior angles and extreme hind margins of second to sixth segments inclusive narrowly cream-buff : paired grey dorsal stripes, grey lateral margins, and grey portion of venter clothed with minute, appressed, whitish hairs ; ventral surface of last three segments, except hind margins of fifth and sixth, greyish clove-brown, hind margins of ventral scutes of second to sixth segments inclusive cream-buff. *Wings* hyaline, *stigma* elongate, faint, and inconspicuous. *Squamæ* isabella-coloured. *Halteres* : knob buff or cream-buff, sometimes brownish at base, stalk brownish. *Legs* : coxæ grey, clothed like femora with whitish hair ; lower surface and distal fourth of front tibiæ black,

distal extremities of middle and hind tibiæ (in ♀ sometimes also lower surface of hind tibiæ) clove-brown; front tibiæ in ♀, except distal fourth, clothed with minute, appressed, glistening white hairs, pale portions of middle and hind tibiæ in ♀ clothed with similar yellowish white hairs.

ANGLO-EGYPTIAN SUDAN: type of ♂ from Khor Arbat, Red Sea Hills, 9. IX. 1909, type of ♀ and one other ♀ from same locality, 11 & 12. IV. 1910, "attacking camels" (*H. H. King*).

Tabanus camelarius is allied to and superficially resembles *T. gratus*, Lw., but, in the female sex at any rate, is distinguishable *inter alia* by the larger size, more conspicuous appearance, and much darker coloration of the frontal callus, which is clove-brown instead of raw-umber-coloured or mummy-brown; by the antennæ being darker, with a less prominent angle on the third joint, and the terminal annuli dark brown or clove-brown instead of ochraceous-rufous; by the median grey abdominal stripe (except on the sixth segment) being of practically uniform width throughout, instead of conspicuously expanded on the third and fourth segments, and by the paired grey abdominal stripes being, instead of continuous, broken up into disconnected spots after the second segment; and lastly by the femora being slate-grey, instead of isabella- or fawn-coloured.

Tabanus mordax, sp. n.

♀.—Length (5 specimens) 12 to 15·4 mm.: width of head 3·75 to 5 mm.; width of front at vertex just under 1 mm. to 1 mm.: length of wing 8·2 to 10·4 mm.

Slaty-black: dorsum of thorax covered with a thin greyish bloom, striped with grey, and clothed with minute, yellowish or whitish hairs; dorsum of abdomen with a more or less distinct, median, longitudinal stripe (composed of elongate, grey triangles, with their apices directed forwards and truncate), between which and lateral margin on each side is a longitudinal series of very conspicuous and sharply defined, oblique, oval, light grey spots; lower portion of front immediately above antennæ produced into a very prominent, shining black transverse protuberance, on the under surface of which the antennæ themselves are situated.

Head: front and occiput grey, face white and clothed with white hair; *front* relatively broad above, narrower below, its uppermost portion clothed with short, black hairs; shining black supra-antennal protuberance extending from eye to eye, and including the sub-callus (the area immediately above the antennæ) and the region between each antenna and the corresponding eye: lower margin of shining black protuberance straight (sometimes emarginate in centre below antennæ), extending from eye to eye just below the level of the antennæ, and forming a sharp contrast with the white face; *frontal callus* (situate just above but not in contact with supra-antennal protuberance) raw-umber-coloured, transversely elongate and flat; *palpi* cream-coloured, proximal joint clothed with long, white hair, terminal joint swollen, not elongate but ending in a sharp point, and clothed on outer side with short, appressed, glistening white hairs, mingled with minute black hairs towards distal extremity; *antennæ* entirely black, clove-brown or dark brown, expanded portion of third joint not particularly broad, and the angle on its upper margin not prominent. *Thorax*: dorsum

grey on front margin, and with a grey stripe on each side, a narrow grey median line extending from front margin to a little beyond transverse suture, and a complete grey stripe between median line and each lateral stripe; viewed from the side, an ill-defined dark brown horizontal mark, partly clothed with black hair, is seen extending from base of wing towards humeral callus; pleuræ and pectus light grey, and clothed with white hair; scutellum clothed above with appressed, yellowish hair. *Abdomen*: the series of truncate triangles forming the median dorsal stripe extends from the base of the abdomen to the hind margin of the fifth segment, and the triangles, like the spots, are clothed with appressed yellowish hair: the paired light grey spots are present on the first six segments, and are disconnected; spots on first segment connected with grey covering of basal angles, spots on following segments usually connected, more or less distinctly, with hind margins; posterior angles of first six segments, and extreme hind margins of second to sixth segments inclusive cream-buff; lateral margins of first four segments grey, clothed, as also are posterior angles of first six segments, with whitish hair; *venter* grey, first four segments and posterior angles of fifth clothed with minute, appressed, whitish hairs, sixth and seventh segments and median portion of fifth clothed with black hair; a broad slaty-black median stripe extending from front margin of second to hind border of fifth segment: sixth and seventh segments (except hind border of sixth) black; hind borders of second to sixth segments inclusive cream-coloured. *Wings* hyaline, veins dark brown; *stigma* elongate, dark brown and conspicuous; *base of anterior branch of third longitudinal vein without an appendix*. *Halteres*: knob cream-coloured, dark brown at base; stalk cream-buff, dark brown at distal extremity. *Legs* slate-grey, tarsi and distal extremities of tibiæ clove-brown or black, front half of proximal two-thirds of front tibiæ cream-coloured, corresponding portion of middle tibiæ and proximal two-thirds of first joint of middle tarsi cream-buff, extreme base of first joint of hind tarsi also cream-buff, coxæ, femora, and front surfaces of tibiæ (except distal extremities) clothed with whitish hair.

Anglo-Egyptian Sudan, and Somaliland: type and two other specimens from Khor Arbat, Red Sea Hills, Anglo-Egyptian Sudan, 9, 10. IX. 1909 (*H. H. King*): a fourth specimen from Karora, Red Sea Province, Anglo-Egyptian Sudan (near the frontier of Eritraea), February, 1909 (forwarded by Mr. H. H. King): a fifth specimen from Heile Madow, R. Webi, Somaliland, 19. XI. 1908 (*Dr. R. E. Drake-Brockman*).

At Karora, according to information supplied by Mr. King, *Tabanus mordax* and *T. leucostomus*, Lw., which it closely resembles, are termed "lamas" by the natives, by whom the bites of both species, as also those of *Pangonia magrettii*, Bezzi, are said to be fatal to camels.

The resemblance between *Tabanus mordax* and *T. leucostomus* Lw.*, is so close as to suggest that the former may ultimately prove to be a *form* of the

* Syn. *T. psusennis*, Jænn.—*T. leucostomus*, Lw., the type of which was obtained on the Kuisip River, German S.-W. Africa, also occurs in Somaliland and Abyssinia, while a female of this species, taken at Karora, Red Sea Province, Anglo-Egyptian Sudan, at the same time as the female of *T. mordax* referred to above, was presented to the British Museum (Natural History) with the latter, by Mr. H. H. King.

latter, rather than a distinct species. While this is certainly possible, it seems for the present advisable—until the question can be definitely decided by the examination of further material belonging to both sexes—to concede *specific* rather than merely *varietal* rank to *T. mordax*. Although on a cursory examination *Tabanus mordax* may easily be mistaken for *T. leucostomus*, since, in the female sex at any rate, the abdominal markings in the two cases are identical, the former may be distinguished from the latter by the great development of the supra-antennal protuberance, and by the absence of an appendix to the anterior branch of the third longitudinal vein.

CURRENT NOTES.

Stegomyia fasciata in North-East Africa.

As a result of the publication of the late Sir Rubert Boyce's article (Bull. Ent. Res. I., p. 233) on the significance of this mosquito in West Africa, Dr. Andrew Balfour, Director of the Wellcome Research Laboratories, Khartoum, has written drawing attention to the fact that the species occurs in various localities in the Sudan. At one time it was fairly numerous in Khartoum itself, but such relentless war has been waged against it during the past seven years that it is now rarely found. Dr. Balfour adds that "there is some evidence to show that *S. fasciata* may transmit the virus of horse-sickness in the Sudan; while recent French work tends to confirm the supposition that it may also act as a vector in dengue fever. Indeed it would seem that there is a close connection between this mosquito and certain of the ultra-visible viruses producing disease in man and animals."

Mr. R. E. Drake-Brockman has also written from British Somaliland to say that *S. fasciata* is very abundant in all the coast towns of that country, except from April to September, when hardly any mosquitos are to be found owing to the terrific heat and the strong hot winds. He had not met with the species anywhere up-country, and considers it to be essentially a town mosquito, breeding in the water-vessels in and about every Arab and Indian house; no larvæ, however, could be found in any of the wells. Attempts have been made to control the breeding of the insects, but it has been found difficult to induce the native population to take the proper precautions. Numerous specimens, bred from larvæ, have been sent home by Mr. Drake-Brockman, which show some interesting variations, the thorax being sometimes quite pale brown, while the dorsum of the abdomen is often so much suffused with whitish scales as to obliterate the conspicuous white banding. A single specimen with a similar whitish abdomen has been taken by Mr. J. J. Simpson, at Lokoja, Northern Nigeria.

Cimex rotundatus in the Anglo-Egyptian Sudan.

Dr. Andrew Balfour writes as follows concerning this bed-bug:—"Hitherto *Cimex rotundatus*, the species of bed-bug which Patton has associated with kala-azar has only been found in the Red Sea Province of the Sudan where it was believed to have been introduced from Arabia by Yemenese. Recently, however, the late Lado Enclave has been taken over from the Belgians and now forms part of the Mongalla Province of the Anglo-Egyptian Sudan. From one of its stations, Loka by name, El-Kaimakam Percival Bey kindly brought me specimens of bed-bugs collected in the native huts, where he informs me there are large quantities of them. On examining his specimens I found them to be *Cimex rotundatus* and not *C. lectularius*, which, so far as is known, is the only species found in Khartoum and in the kala-azar districts of Sennar, Kassala and Kordofan.

"As Captain Archibald is at present in the Lado District on Sleeping Sickness work, I have wired him to be on the look out for cases of kala-azar, while as Mr. King, our Entomologist, is also in that region we are likely to obtain full

information regarding the distribution of this bed-bug both in the Lado and in the Bahr-El-Ghazal. It is worthy of note that the first case of kala-azar found in the Sudan by Neave was a boy who had recently come from Meshr-El-Rek, in the Bahr-El-Ghazal Province."

Although it is quite probable that *C. rotundatus* may have been introduced into the Red Sea Province of the Sudan, from Arabia, yet there seems reason to believe that this species is the common bed-bug of Tropical Africa. Examples of it have recently been received by the Entomological Research Committee from the following localities:—NYASALAND: North Rukuru River (*Dr. J. B. Davey*), Zomba (*Dr. H. Hearsey* and *A. M. D. Turnbull*), Blantyre (*Dr. J. E. S. Old*); N. E. RHODESIA: various localities (*S. A. Neave*); NORTHERN NIGERIA: Zungeru (*J. J. Simpson*); SOUTHERN NIGERIA: Benin City (*Dr. R. W. Gray*); whereas no *C. lectularius* have been sent from these localities.

A Locustid injurious to Man.

With reference to this subject, Dr. Hugh S. Stannus writes from Zomba, Nyasaland, as follows:—"In a recent number of the Bulletin Dr. C. A. Wiggins, of Entebbe, Uganda, gives notes upon a Locustid, *Enyaliopsis durandi*, whose bite, he says, 'gives rise to a very nasty eruption . . . the skin at the site of the bite sloughs away,' &c. An editorial note states that immature specimens of the allied *E. petersi* emits a clear yellow fluid from the sides of the body when handled, and mentions that these insects have no poison glands. For some years I have been cognisant of the fact that among the natives of Nyasaland an allied if not the same species is held to cause skin lesions by the emission of a fluid on the bare skin surface of the body. The Yao name for the insect is 'Nantundira' (from 'kutunda,' to make water): the Anyanja call it 'Nalibvibvi.' I have seen cases of ulcers on various parts of the body for which the 'Nantundira' was assigned as the cause.

"Curiosity prompted me to seek further, and having asked for a volunteer, I procured a specimen of the Locustid in question, and tested the truth of the native statement. The insect was put on to the arm of the native, and then worried with a penholder. It promptly emitted a slightly yellowish clear fluid from pores at the side of the body near the junction of the thorax and abdomen. This secretion was allowed to remain on the arm. In a few hours a sensation of burning was produced, the skin showed signs of reaction, swelling and redness, and twelve hours later the superficial layers appeared to be dissolved, so that the pink skin beneath was visible, covered by a serous exudation. This superficial destruction of tissue healed in a few days without trouble. The secretion was acid to litmus.

"I have little doubt that such a breach of surface may in many cases be the starting point for extensive ulceration, if it becomes infected, as in a similar way small abrasions in the native are often followed by ulceration, owing to lack of proper treatment. I am inclined to think that Dr. Wiggins, in using the term 'bite,' is repeating native evidence, and that the explanation of the production of ulceration and sloughing is the same as I have mentioned as occurring in this country."

Glossina brevipalpis as a probable vector of trypanosomiasis of Cattle in Nyasaland.

With reference to a remark by Dr. Meredith Sanderson (Bull. Ent. Res. I, p. 302) that large herds of cattle remain healthy in North Nyasa in the presence of *G. brevipalpis*, Dr. J. B. Davey writes:—"In 1905 the Government made the experiment of keeping two head of cattle at Masinjiri's, in the Elephant Marsh, 18 miles from Chiromo, where *G. brevipalpis* was abundant. As these cattle died they were replaced by others from Chiromo, where there was no cattle-disease and no *Glossina*. I paid a visit to Masinjiri's on the 27th July, 1905, and found that a young bull which had been there about three months, had a small number of trypanosomes in its blood; it was reported dead two days later. At the same visit I examined the second animal there, but found no trypanosomes, as it had only been there two days. I went again on the 9th October, and found trypanosomes in a young bull which died on the 17th October. On the 18th December, 1905, the sole surviving beast at Masinjiri's was brought back to Chiromo, and the experiment terminated; its blood showed fairly numerous trypanosomes and it died ten days later.

"The experiment had been carried on for some time before my arrival at Chiromo, but no observations were made beyond reporting the deaths as they occurred, and I cannot say how many cattle died altogether. So far as I can remember, they used to get sick about two months after being sent to Masinjiri's. *G. brevipalpis* was constantly found at this place while the experiment was being made.* About the same time I found a very few trypanosomes in the blood of a buffalo which I shot two or three miles out of Chiromo; these buffalo wander about and almost certainly visit Masinjiri's. From the above observations I think it would be rash to say that cattle remain healthy when exposed to *G. brevipalpis*."

Dr. Davey also states that Dr. Sanderson appears to have been mistaken in saying that there had been a case of sleeping sickness in North Nyasa, as there is no official record to that effect. As regards the transmission of cattle-disease by *G. brevipalpis*, it may be noted that Mr. Austen (Handbook of the Tsetse-flies, p. 91) cites Stuhlmann to the effect that this species is the chief disseminator of Tsetse-fly disease among domestic animals in the German East African littoral, at any rate. It is possible that Dr. Sanderson's observations may indicate that the game in the district between Karonga and the Songwe River is practically free from trypanosomes, in which case it would not be a source of danger to stock even in the presence of *Glossina*.† Further, Mr. S. A. Neave has recently taken *G. brevipalpis* inland in German East Africa at the Baka River, on the main road between Mwaya and New Langenburg; and again,

* [Up to the present *G. brevipalpis* is the only species of tsetse which has been recorded from the Elephant Marsh.—Ed.]

† [Since the above was written we have been informed by Dr. H. S. Stannus that there have been cases of trypanosomiasis quite recently among the cattle in the district referred to. No specimens of *G. morsitans* have been received as yet from this area.—Ed.]

at the crossing of the Ruaha River, on the Iringa-Kilossa Road. He writes:—"It is of interest to note that in both cases there were considerable herds of apparently healthy cattle in the immediate vicinity and coming to water at these very spots."

Bembex preying upon Tabanidae.

Mr. C. C. Gowdey, the Government Entomologist in Uganda, writes that he has recently captured two specimens of *Bembex tricolor*, Dahlb., each of which was carrying off an example of *Tabanus secedens*, Walk., to its burrow. The insects were found near Kangai, on the bank of the Kabalanga River, which flows from Lake Kwania, in the Bululu District. It may be recalled that *T. secedens* has been mentioned in the reports of the Sleeping Sickness Commission as a possible vector of *Trypanosoma pecorum* (Bull. Ent. Res. I., p. 222).

Mr. S. A. Neave has also sent, from the Ruaha Valley, German East Africa, a *Bembex capensis*, Lep., which was preying upon a Tabanid, *Holcocerina nobilis*, Grünb. He notes that "in this locality there can be little doubt that, at this season at least, these Hymenoptera are very important enemies of TABANIDÆ. Numbers were to be seen hawking round cattle and other domestic animals during the heat of the day in search of these flies: so much so, that the difficulty of collecting the flies was much increased, as they mostly took refuge under the animals' bellies."

Fish preying upon mosquito larvæ in Uganda.

Mr. C. C. Gowdey, Government Entomologist in Uganda, writes that he has made experiments with two Cyprinodont fishes, which he believes to be *Fundulus tæniopygus* and *Haplochilus pumilus*, and finds that they devour mosquito larvæ voraciously. But he adds:—"The Cyprinodonts in Uganda could never, in my opinion, play such an important part in the destruction of mosquito larvæ as does *Girardinus poeciloides* in Barbados: for here there are numerous rivers and swamps, overgrown with papyrus and reed-like grasses, in which mosquito larvæ are abundant and where these Cyprinodonts are not found and will not live."

It would be rash to assume that these fish cannot be established in waters in which they do not occur naturally. For, apart from the fact that their normal powers of dispersal must be comparatively limited, especially where isolated pools or swamps are concerned, even if a definite inhibitive factor exists, it might yet be possible by the continual introduction of fresh batches eventually to establish a resistant strain; or again, it might be possible to remove or mitigate the adverse conditions, when they have been ascertained.

INVESTIGATION INTO THE HABITS AND DISTRIBUTION OF TSETSE-FLIES.

The Entomological Research Committee are indebted to the following gentlemen, who have kindly forwarded information respecting the above-mentioned subject, in response to circulars issued by the Committee :—

Mr. A. L. Barnshaw, Chipando, Abercorn, North Eastern Rhodesia.
Mr. James A. Chisholm, Mwenzo, Fife, North Eastern Rhodesia.
Mr. H. Forsyth, Dell Farm, Fife District, North Eastern Rhodesia.
Mr. Henry C. Gouldsburg, Acting Native Commissioner, Mporokoso, North Eastern Rhodesia.
Mr. E. B. Haddon, Assistant District Commissioner, Gondokoro, Nile Province, Uganda.
Mr. Hubert T. Harrington, Native Commissioner and Assistant Magistrate, Luapula District, North Eastern Rhodesia.
Capt. G. Lane, R.A.M.C., Medical Officer, Mbarara, Uganda.
Mr. Hugh C. Marshall, Magistrate, Abercorn, North Eastern Rhodesia.
Rev. M. Moffat, Chitambo Station, Livingstonia Mission, Serenje, North Eastern Rhodesia.
Mr. W. A. Powell, Marama, North Eastern Rhodesia.
Rev. J. van Schalkwijk, Dutch Reformed Church Mission, Nyanji Station, Petauke, North Eastern Rhodesia.
Mr. H. Thornicroft, Assistant Magistrate, Petauke, North Eastern Rhodesia.
Mr. R. A. Young, J.P., Native Commissioner, Chinsali, North Eastern Rhodesia.

COLLECTIONS RECEIVED.

The thanks of the Entomological Research Committee are due to the following gentlemen, who have kindly presented collections of insects (received between 1st January and 31st March, 1911) :—

Dr. J. W. Archibald :—56 Culicidæ, 40 Tabanidæ, 120 *Glossina*, 2 Hippoboscidæ, 72 Other Diptera, 1 Coleopteron, 1 Odonate, 4 Neuroptera, 86 Hymenoptera, and 54 Lepidoptera ; from Gambia.

Mr. H. T. Barrett :—65 *Glossina morsitans*, 5 Hippoboscidæ, and 3 Ticks ; from Portuguese East Africa.

Bureau of Entomology, Washington :—11 paratypes of *Pleurotropis telenomi*, Cwfd., 16 paratypes of *Telenomus gowdeyi*, Cwfd. (Chalcididæ) ; from Uganda.

Dr. Collett :—33 Culicidæ, 11 Tabanidæ, 5 *Glossina*, 15 other Diptera, 5 Hymenoptera, 12 Coleoptera, 6 Lepidoptera, and 3 Orthoptera ; from Southern Nigeria.

Dr. A. Connal :—41 Culicidæ, 91 Culicid larvæ, and 7 other Diptera ; from Lagos, Southern Nigeria.

Dr. J. G. Copland :—30 Tabanidæ, and 37 *Glossina* ; from Aro, Southern Nigeria.

Mr. E. Dayrell :—59 *Tabanus* ; from Ikom, Southern Nigeria.

Dr. Fatteh ud Din :—11 Culicidæ, 11 Tabanidæ, 2 Lepidoptera, 3 Coleoptera, 1 Hymenopteron ; from Masaka, Uganda.

Capt. A. D. Fraser :—7 *Tabanus*, 13 *Hæmatopota*, 1 *Chrysops* ; from Uganda.

Dr. Gallagher :—3 *Culiciomyia*, 12 *Glossina palpalis*, and 3 other Muscidæ ; from Gambia.

Mr. C. C. Gowdey :—4 *Tabanus*, 3 *Hæmatopota*, 39 other Diptera, 16 Chalcididæ. 37 Rhynchota. 12 Orthoptera, numerous Coccidæ, 42 Coleoptera, 125 Thrips, 17 Hymenoptera, 11 Lice and 28 Ticks ; from Uganda.

Dr. R. W. Gray :—6 *Glossina palpalis*, 1 *G. longipalpis* ; from Benin Dist., S. Nigeria.

Mr. J. A. Ley Greaves :—122 *Glossina palpalis*, 1 *G. tachinoides*, 1 *G. morsitans* and 2 *G. fusca* ; from Kabba Province, N. Nigeria.

Dr. Hailstone :—2 *Tabanus*, 200 *Hæmatopota brunnescens* Ric., 1 *Glossina palpalis*, 153 *Simulium damnosum*, 2 Hymenoptera, 13 Fleas, 1 Louse and 38 Ticks ; from Usoga, Uganda.

Dr. R. C. Hiscock :—2 Culicidæ and 2 other Diptera ; from Offa, S. Nigeria.

Dr. E. Hutchins :—23 Ticks ; from Uganda.

Mr. C. W. Jemmett :—36 Coleoptera ; from Southern Nigeria.

Mr. W. A. Lamborn :—1 Tabanid, 1 *Glossina*, 3 other Diptera, 11 Orthoptera, 166 Rhynchota, and 7 Coleoptera ; from Southern Nigeria.

Liverpool School of Tropical Medicine :—7 *Glossina*, including types of *Glossina brevipalpis*, Newst., and *G. submorsitans*, Newst.

Dr. O. S. F. Luhn :—4 Culicidæ, 8 Tabanidæ, 15 *Glossina*, 3 other Diptera, and 2 Hymenoptera : from Obokum, Southern Nigeria.

Dr. F. W. McCay :—269 *Glossina* ; from Northern Nigeria.

Dr. C. H. Marshall :—9 *Tabanus*, 25 *Hæmatopota*, 20 *Glossina*, 1 *Philæmatomyia insignis*, Aust., 2 *Simulium damnosum*, 77 other Diptera, 4 Rhynchota, and 28 Ticks : from the Bugoma and Budonga Forests, Uganda.

Dr. T. F. G. Mayer :—348 Culicidæ, 11 *Glossina*, 4 *Tabanus*, 4 *Chrysops*, 14 *Hæmatopota*, 3 *Stomoxys*, 1 *Auchmeromyia luteola*, 1 Hippoboscid, 108 other Diptera, 11 Rhynchota, 12 Hymenoptera, 1 Lepidopteron, 4 Orthoptera, and 45 Ticks ; from Southern Nigeria.

Mr. S. A. Neave :—62 Culicidæ, 2,491 Tabanidæ, 126 *Glossina*, 75 *Stomoxys*, 38 Hippoboscidæ, 48 *Auchmeromyia luteola*, 3 *Simulium*, 20 *Phlebotomus*, 130 other Diptera, 725 Lepidoptera, 1,385 Rhynchota, 154 Cimicidæ, 120 Fleas, 75 Pupæ, 236 Orthoptera, 381 Coleoptera, 81 Anoplura, 368 Mallophaga, 25 Neuroptera, 1,567 Hymenoptera and 550 Ticks ; from N. E. Rhodesia, Nyasaland, and German East Africa.

Dr. J. E. S. Old :—7 Culicidæ, 29 Tabanidæ, 71 *Glossina*, 4 *Auchmeromyia luteola*, 110 other Diptera, 119 Hymenoptera, 12 Neuroptera, 224 Rhynchota, 21 Lepidoptera, 151 Coleoptera, 15 Orthoptera, 8 Fleas, 6 Ticks, 1 Millipede, numerous worms ; from Nyasaland.

Dr. H. B. Owen :—8 *Tabanus* ; from Koba, Uganda.

Dr. G. J. Pirie :—5 Culicidæ, 43 *Tabanus*, 6 *Chrysops*, 7 *Hæmatopota*, 20 *Glossina*, 4 *Stomoxys* and 5 Hippoboscidæ ; from Northern Nigeria.

Dr. A. C. Rendle :—7 Culicidæ, 39 *Tabanus*, 1 *Glossina palpalis*, 5 other Diptera, 2 Rhynchota, 1 Coleopteron and 2 Hymenoptera ; from Nile Province, Uganda.

Mr. J. J. Simpson :—78 Culicidæ, 193 Tabanidæ, 158 *Glossina*, 12 Hippoboscidæ, 107 other Diptera, 26 Odonata, 79 Hymenoptera, 19 Orthoptera, 27 Coleoptera, 138 Lepidoptera, 100 Rhynchota, numerous Coccidæ, 1 Neuropteron, 4 Ticks, 5 Spiders ; from Northern Nigeria.

Dr. A. W. Smythe :—12 *Glossina* and 115 *Tabanus* ; from Forcados, S. Nigeria.

Dr. H. S. Stannus :—23 Culicidæ, 104 Tabanidæ, 2 *Auchmeromyia luteola*, 47 other Diptera, 34 Orthoptera, 3 Rhynchota, 29 Fleas, a number of Aphidæ, 12 Larvæ, 3 Lice, 44 Ticks and numerous worms ; from Zomba, Nyasaland.

Mr. F. V. Theobald :—30 Mosquitos (named) of 17 species ; from the Transvaal.

Dr. R. van Someren :—157 Culicidæ, 26 Chironomidæ, 43 *Hæmatopota*, 1 *Chrysops*, 84 *Glossina*, 16 puparia of *Glossina*, 33 Hippoboscidæ, 6 *Stomoxys*, 28 Dipterous larvæ, 34 Ticks, 6 Coleoptera, 1 Hymenopteron, 4 Rhynchota, 3 Orthoptera, 23 Mallophaga, 4 Neuropterous larvæ, 13 Worms and 2 Leeches ; from Uganda.

Dr. C. E. S. Watson :—17 Culicidæ, 5 Tabanidæ, 18 *Glossina*, 3 other Diptera, 10 Coleoptera, 23 Coleopterous larvæ, 4 Orthoptera, 7 Hymenoptera, 5 Rhynchota and a number of worms ; from N. Nigeria.

Dr. C. A. Wiggins :—44 Culicidæ, 20 *Tabanus*, 8 *Hæmatopota*, 1 *Chrysops*, 2 *Glossina*, 1 *Auchmeromyia luteola*, 5 other Diptera; 9 Coleoptera, 22 Hymenoptera and 2 Orthoptera ; from Entebbe, Uganda.

ENTOMOLOGICAL RESEARCH IN BRITISH WEST AFRICA.

I. GAMBIA.

By Jas. J. Simpson, M.A., D.Sc.

(with a Map showing the distribution of Glossina *and Sleeping Sickness, and* 13 *photographs by the author.)*

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Introductory.

In this short report it is proposed to deal exclusively with the blood-sucking insects and other Arthropods which are, or may be, implicated in the transmission of disease in man and animals. In this connection, however, certain aspects, geographical and geological, are necessarily involved, but these will be introduced only when considered to be directly relevant to the main issue.

Our knowledge of this subject, in regard to all West African British Possessions, is very meagre, but perhaps not more so in any than in the Gambia. Prior to the Expedition of the Liverpool School of Tropical Medicine in 1902–3, conducted by Drs. Dutton and Todd, little or nothing was known, and since that time only a few isolated records and observations, which will be referred to later, have come to hand. Several factors exist which may account for this state of things, but the most obvious is that only a few of the officials are compelled to leave Bathurst in discharge of their duty. Perhaps still more important is the fact that those who are interested in such work, and whose observations would be of great value, do not possess the small amount of material necessary for the purpose. Again the question of technique and the identification of material collected have always raised difficulties, but these are now reduced to a minimum, and it is hoped that this short Report, with its appended map,* may show how

* The villages in which human trypanosomiasis was diagnosed by the Expedition of the Liverpool School of Tropical Medicine in 1911 have been indicated on the map so as to make it more complete. For fuller details of these see Ann. Trop. Med. and Paras. Series T. M. Vol. V. No. 2, pp. 245–286.

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little has been done, and thus stimulate others to add their quota so as to bring the Gambia into line with other parts of the world.

An appendix has been added emphasising the chief points to be observed in collecting and preserving insects for identification, and indicating the method by which such collections will be identified, acknowledged, and incorporated with previous work.

I. Insect-borne Diseases.

Before we proceed to the purely entomological part, it might be well to draw attention to some of the factors which necessitate such work being carried out, and, in this connection, the occurrence and prevalence of insect-borne diseases command primary consideration.

(*a.*) Malaria, as in all the other West African Colonies, is almost universally distributed, and is by far the commonest insect-borne disease of the Gambia.

(*b.*) Yellow Fever is far from infrequent, however, and in May of this year four Europeans in Bathurst succumbed to it. In 1904 the late Dr. Dutton pointed out that *Stegomyia fasciata* was the mosquito most frequently met with in Bathurst, but this is not now the case, though, even in the dry season, numbers of this species are always present. At the end of April, while stationed in the Military Barracks at Bathurst, I caught several *S. fasciata* in that building, and it is noteworthy in this connection that two of the four Europeans who died of yellow fever were quartered in an adjoining building within the same enclosure.

(*c.*) Sleeping Sickness is endemic in the Gambia. In 1901–2, two Europeans and six natives were found to be suffering from this disease and since then one other European contracted it in the Colony. In the spring of this year, Drs. Todd and Wolbach made an investigation of the sleeping sickness in the Gambia, and, after an examination of a very large number of natives, concluded that about 0·8 per cent. are probably affected with *Trypanosoma gambiense*. This is a fairly high percentage, and although there never have been regular epidemics, and the natives may have acquired some sort of immunity or resisting power, still the question of transmission to Europeans is too serious a factor to be lightly passed over.

(*d.*) Animal Trypanosomiasis is also very prevalent; a large percentage of the cattle are infected, and the rate of mortality amongst horses is high.

With these facts kept well in view, the importance of a fuller knowledge of the various species of blood-sucking flies, their distribution, habits, and life-history must take a high place in any economic consideration of the Colony.

II. Geography and Vegetation.

The Colony and Protectorate of the Gambia is the most westerly and, at the same time, the most northerly of our West African possessions, being approximately in the same latitude as the north of Northern Nigeria. Its extreme limits north and south are approximately 13° 48′ N., and 13° 4′ N., while 13° 46′ W., and 16° 50′ W. may be taken as its eastern and western limits. It is a long narrow strip of country on the banks of the river from which it takes its name, and lies practically east and west. At no part is it more than 30 miles wide, while in some places it is only 15. Its total area is roughly about 5,000 square miles.

The River Gambia rises near the source of the River Senegal on the north-east slope of the Footah-Jallon Mountains, to the north of Sierra Leone, and little more than 200 miles from the sea-coast. It flows first in a northerly direction and then west, entering British territory in, roughly, 13° 46′ W. For a short distance it forms the boundary of the French and British spheres of influence, but after the village of Bananko both banks are in British territory. It enters the sea about 100 miles south of Cape Verde, the most westerly point of Africa. The river is an important water-way, but though navigable for ocean-going steamers for about 250 miles from the sea, does not lead beyond the coast region.

At Barraconda, 257 miles from Bathurst, there are falls or rapids, which make navigation even in the wet season difficult for any but very small steamers. Ocean-going steamers can, however, reach MacCarthy Island, 153 miles from Bathurst, at all times of the year. This is very important, inasmuch as European crews spend considerable time alongside the various wharves, subjected to all the influences of a tropical climate, and more often than not, without the usual precautions.

The river is 27 miles wide at its mouth, but opposite Bathurst, 18 miles up, it is only 2½ miles wide; it then gradually narrows, until near MacCarthy Island it is less than half a mile in width. No tributaries of any size pour their waters into the Gambia in British territory, and although numerous creeks of various sizes penetrate inland, they may be considered more as backwaters and overflows than as actual tributaries; they generally end in swamps, which are firm ground in the dry season, and which are used by the natives for rice farms. This must be borne in mind in connection with much of what follows and is of great importance in the question of tsetse distribution. The largest of these creeks is the Bintang Bolon (creek), which will be considered in greater detail later on. (*See* figs. 10 and 11.) The country through which the river flows is open, as compared with the forest belt of West Africa, which commences some 60 or 70 miles further down the coast, and extends to Accra on the Gold Coast. The valley of the river from MacCarthy Island to the end of British territory is hemmed in by low rocky hills of volcanic formation from 50 to 100 feet high, while the character of the surrounding country is park-like.

A study of the vegetation on the river banks necessarily involves a consideration of the nature of the water at various points, and this also in both the wet and the dry seasons. Towards the end of the wet season (*i.e.*, October, November) the water is fresh down to the Suarra-Kunda creek, but in the dry season the fresh water recedes to a point a few miles east of Ballangar. From this point to Elephant Island the water is brackish, while below this the full influence of the sea is marked. The banks of the river, from its mouth to Ballangar, are fringed with mangrove swamp, behind which are plains densely covered with coarse grass, growing to a height of ten feet or over, and interspersed with thin bush and clumps of timber. The district between Ballangar and Barijali forms a transition stage in which there are mangroves in front, and trees, shrubs, palms, ferns, pandani, etc., in the background, the former diminishing, the latter increasing in number and extent the higher one ascends. Onwards from Barijali no mangroves are seen, and different parts of the bank show a varying preponderance of scrub, palms, etc., mentioned above (fig. 8).

It is thus seen that the mangrove area corresponds, at any rate in the Gambia, with the extent to which the tidal influence is felt in the dry season. The nature of the vegetation behind the bank-fringe varies but little in the whole course of the river, except perhaps in the Niumi Province (the most westerly on the North bank), where there is a dense forest of small trees of no great extent.

The river is studded, especially in its middle portion, with islands of various sizes. The chief of these are :—Fort James, Elephant, Pappa, Pasul, Pasali, Ba Faraba, Baboon, Kai-ai and MacCarthy Islands. None of these, however, are inhabited, except MacCarthy Island, which will be referred to later. With the exception of Fort James Island, which is merely a large rock in the middle of the river, and which was formerly used as a fortress, they are all densely covered with vegetation which partakes of the character of that on the corresponding part of the river banks, and are literally swarming with flies, which make a fierce attack on the occupants of passing craft.

Having thus considered the types of vegetation which fringe the river banks, let us now proceed to an analysis of the different plant associations in what may be termed the interior. Only in one part, namely, the Niumi Province in the north-west, is there anything approaching a tropical forest. This consists of trees of vastly different sizes, with a dense undergrowth of small scrub, bound together by epiphytes of various kinds. In places, however, and especially towards the edge, the large trees disappear and are replaced by smaller forms of a more uniform size, while the ground is covered with grass interspersed with a few small shrubs. Epiphytes are almost entirely absent.

Scattered throughout the whole Colony are fresh-water swamp forests of very limited extent ; they occur generally in long belts and vary considerably in formation. Some contain very large trees scattered amongst others of a smaller size, while the ground is covered with a matted net-work of shrubs. Figure 1 shows a path cut through a belt of this type. In others the large

Fig. 1.—Path leading to well near Bakau Village. A fresh-water swamp forest in which *G. palpalis* are abundant.

trees are replaced by evergreen shrubs and bushy trees. These furnish considerable shade, though not so dense as in the previous type, and are always associated with a tangled undergrowth. Figure 2 is typical of this class, while

Fig. 2.—View near Bakau. Belt of evergreen shrubs and bushy trees with tangled undergrowth—a typical *palpalis*-haunt.

fig. 5 shows certain modifications, in which the proportions of trees, bush, and undergrowth vary, and where Oil and Borassus Palms make their appearance. The variation in the nature of these belts is due almost entirely to the amount of surface moisture, the greater the amount of moisture the denser the undergrowth.

Where laterite predominates, and where there is consequently a much greater desiccation during the dry season, there are extensive stretches of thin bush. In this type, the trees are small, more or less crowded, and present a stunted and gnarled appearance. They are all deciduous, and there is little if any undergrowth. Such small shrubs and grass as appear during the rains disappear soon after the middle of the dry season. In laterite outcrops, where the influence of the rains is hardly felt, large expanses of small bamboos of stunted appearance are met with.

A still more open type of country is seen in fig. 6 where there are practically no trees of any description and very little bush, but where grass predominates; this is associated with sandy soil and is the favourite site for villages and farms.

III. Climate and Rainfall.

The year is clearly divided into two seasons, a wet and a dry. The wet season continues from June to September inclusive, while the other seven months constitute a period of drought. The rainy season begins and ends with tornadoes, which commence early in June, and the rains proper about the end of July. The maximum rainfall (between one-third and one-half of the total for the year),

occurs during the month of August. The following Table A. gives the total rainfall at Bathurst for the past 10 years, and at MacCarthy Island for the years 1908–10, while Table B. shows the distribution for the various months both for Bathurst and MacCarthy Island during the years 1908–10.

TABLE A.

Rainfall in the Gambia.

	Bathurst.	MacCarthy Island.
1900	43·38	—
1901	45·31	—
1902	29·42	—
1903	57·13	—
1904	38·02	—
1905	66·07	—
1906	64·36	—
1907	34·00	—
1908	43·54	35·89
1909	56·59	42·03
1910	44·00	35·40
Average	47·44	37·77 (for 3 years)

TABLE B.

Monthly Record of Rainfall in the Gambia.

	1908.		1909.		1910.	
	Bathurst.	MacCarthy.	Bathurst.	MacCarthy.	Bathurst.	MacCarthy.
May	—	—	—	0·10	—	—
June	1·58	3·25	6·13	9·68	1·15	2·88
July	9·75	7·70	8·87	10·24	11·98	9·43
August	24·67	13·11	19·89	12·37	16·60	10·72
September ...	5·35	10·35	17·30	6·85	11·52	9·86
October	2·14	1·48	4·40	2·79	2·75	2·20
November ...	—	—	—	—	—	0·31
December ...	0·05	—	—	—	—	—
Total ...	43·54	35·89	56·59	42·03	44·00	35·40

The most noteworthy feature in these tables is the enormous variation in the different years, *e.g.* 29·42 inches in 1902 as compared with 66·07 inches in 1905. In 1908, 24·67 inches, or more than half the amount for the year, fell during the month of August. The rainfall at MacCarthy Island is never so great as that at Bathurst.

The dry season, from November to May, is the season of excessive heat and cold; the highest maximum recorded for Bathurst was 104° in May 1904 and 1906, while the lowest minimum was 46° in December 1900. The Harmattan, a north-east wind blowing from the Sahara, cold at night, and extremely hot and dry by day, blows intermittently from December to April. The range of temperature within 24 hours during this season is enormous, amounting sometimes to 30° at Bathurst and 59° up-country, but, in the latter district, 40° is not uncommon. The excessive dryness of the air during the dry season may be gauged by the fact that at Bathurst there is sometimes a difference of 22° between the wet- and dry-bulb thermometers, while up-country it is often greater. The mean temperature for the year at Bathurst is, however, not exceedingly high, ranging between 75° and 85°, owing to the cool sea-breeze from the Atlantic, but up-country, beyond reach of the sea-breeze, it is usually about 20° higher than at Bathurst.

IV. The Tribes inhabiting the Colony and Protectorate.

According to the Census of 1901, the total population of the Colony and Protectorate was slightly over 90,000, but it is more than probable that this figure was considerably under the actual population. The details of the Census of 1911 are not yet available.

The natives of the Gambia belong to four distinct tribes: Mandingoes, Foulahs, Joloffs and Jolahs. Although there are a few professional fishermen at Bathurst and a certain amount of desultory fishing is carried on up-river, no tribe is to any extent dependent on the river for food. The country is essentially suitable for farming and cattle-rearing, and all four tribes carry on both these industries, though in varying degrees. Permanency of occupation of villages and the degree of segregation varies with the different tribes. The principal agricultural export from the Gambia is ground nuts or monkey nuts (*Arachis hypogaea*), and of these some 35,000 to 40,000 tons are exported annually. Guinea corn, maize, millet, rice, cassava, etc., are extensively grown for local consumption. The villages are situated generally in the centre of the area being farmed, and this always ensures an extensive clearing surrounding them. As the nature of the vegetation fringing the banks of the river precludes the possibility of any large settlement being established in the vicinity of the river itself, habitations are not found actually on the river banks, except in a few isolated instances, where there are wharves or ferries. The importance of this is obvious, inasmuch as where there are extensive clearings there are few or no tsetse, and the chances of infection by trypanosomiasis are accordingly diminished.

The Mandingoes are by far the most numerous tribe and are to be found scattered over the whole Colony and Protectorate. They are an agricultural people and live in large, well-built and cleanly-kept villages. There are generally a few large trees in each village, but in very few cases does one see

any low scrub. A feature worthy of mention is the nature of the wells. These are generally dug outside the village and are usually about 30 to 40 feet in depth. The top is raised above the level of the surrounding ground, and the mouth is formed of large tree trunks well bound together. The area surrounding them is cleared and kept unusually clean.

The Joloffs inhabit chiefly the northern bank of the river and extend into Senegal. They also are an agricultural people and live in large permanent villages. In most of their habits which have a bearing on this subject, they resemble the Mandingoes.

The Foulahs, on the other hand, are more a pastoral than an agricultural people: they are closely connected with the Fulani of Northern Nigeria and own large herds of cattle. They are a somewhat nomadic tribe and are found all over the colony, but mostly in the upper reaches of the river. They have no permanent towns but only temporary shelters, and shift from place to place according to the requirements of their cattle. In the wet season they recede from the river and return towards it in the dry season, when the grass is burnt up in the more remote parts. For this reason, their settlements are never so well built nor so cleanly kept as those of either the Mandingoes or Jollofs. They never keep their cattle long in the vicinity of the river, and thus the latter are less liable to attacks from tsetse, and the fact that the Foulahs recede during the rains accounts, to a great extent, for the enormous herds which one sees all over the Colony. Though they give no reason for it, nor seek any, they recognise that a prolonged stay near the river or creeks, is nearly always accompanied by a higher rate of mortality in their herds.

The Foulahs are divided into three sub-tribes: Teucolors, Loubis and the Foulahs proper. The Teucolors are strict Mahommedans, and their language differs slightly from the true Foulah, as may be seen in the words given on page 219.

The Jolahs are a very primitive and low type of natives, who inhabit the district of Fogni and spread into the French territory to the Casamance River. They are very unapproachable, jealous of their rights, and extremely vindictive. They do not segregate themselves into villages, but live in small compounds scattered about, each containing a separate "family." They are chiefly an agricultural people.

In addition to the foregoing, several other factors must be taken into consideration in connection with the spread of disease in man and animals. The political boundaries of the Colony of the Gambia are purely arbitrary and very artificial, and the River Gambia being the only water exit to the coast for the greater portion of French Senegal, a large amount of produce from the surrounding country passes to the coast by this river. This entails considerable intercourse between the natives inhabiting the river area and those from the high lands beyond. There is, further, considerable dealing in cattle between the two peoples, and thus the possibility of infected cattle finding their way into the upper regions is a very likely one. But more significant, however, is the fact that there is a large migratory farming community in the Gambia. Year after year, large numbers of natives from French and Portuguese territory come over to British territory and farm large tracts of land, returning to their homes as

soon as the produce, which consists chiefly of ground nuts, is disposed of. The possibility, therefore, of diseases being carried from or into adjoining countries is by no means remote.

V. Narrative.

Having now considered the geographical position of the Colony, its general physical conditions and plant associations, the climate and rainfall, and the natives, let us deal in greater detail with the localities visited, and see to what extent each and all of these factors influence the existence and distribution of the various members of the group of insects under consideration.

The dotted line on the appended map shows the route traversed by the author.

It was my intention to proceed up one bank of the river, cross over to the other bank at the extreme limit of British territory, and work back to Bathurst. My stay in the Colony extended from February 18th to May 1st, the last two and a-half months of the dry season, the only season of the year when it is possible, for Europeans at least, to do any considerable touring. Consequently, owing to the short time at my disposal, my proposed journey was found to be impossible, and therefore only typical portions were visited; while in addition to these, through the kindness of His Excellency the Governor, I was enabled to examine in the Government steamer the whole river to MacCarthy Island and also the Bintang Creek—by no means the least valuable portion of the investigation.

(*a*). Bathurst and Cape St. Mary.

Bathurst is the capital and principal settlement of the Colony. It is the only town having permanent European residential quarters. It is situated on the extreme eastern end of the Island of St. Mary. This island has an area of about four and a half square miles, and is little more than a mixture of swamp and sandbank, inundated during the rainy season. Although much has been done to fill up the swamps and drain the whole area, much still remains to be done to make the town a model tropical settlement. Commercially, the position is good, but residentially it is far from satisfactory, in spite of untiring efforts on the part of the Senior Medical Officer and his staff. Mosquitos, including *Stegomyia fasciata*, are to be found in considerable numbers. This is due in great part to the surrounding marshes, but also to the confined nature of most of the residential quarters and the lack of access of free air to these on account of the lower parts being used, in nearly all cases, as stores, &c. The close proximity of the stables to the residential quarters (in some cases they are part of the same building) is a fact much to be deprecated. Tsetse do not infest the town during the dry season, but, I am told, are not infrequent visitors during the rains.

An exhaustive report on the town, from an entomological aspect, has already been published by the late Dr. Dutton; and, from my short stay and examination, I do not feel justified in amending or adding to this excellent piece of work. I understand that a scheme is on foot to remove the residential quarters from Bathurst to the vicinity of Cape St. Mary, and in view of the recent epidemic of yellow fever, when four Europeans died in one week, some such drastic measure is necessary. Cape St. Mary is situated about seven miles from

Bathurst, and is separated from it by an island, but both creeks are bridged. The Cape itself is situated on the mainland, and has a northerly and westerly exposure to the full force of the cool, invigorating, Atlantic breeze. Even in the hot season, when work is carried on in Bathurst under adverse climatic conditions,

Fig. 3.—View of the coast bluff at Cape St. Mary.

Fig. 4.—View of the beach at Cape St. Mary, showing Government House on a high rocky bluff.

there is a steady cool breeze at the Cape. For miles along the western aspect there is a high bluff some 50 or more feet above high-water. Near the Cape itself there stands a substantial Government House, built of stone and overlooking the sea, while several Bathurst merchants and others have built private houses there, which they use as week-end health resorts.

At the request of Dr. Hood, the Senior Medical Officer for the Colony, I visited and examined this whole area as a possible site for a sleeping-sickness camp. When in the Colony, I submitted to him a short report, but the following notes summarise the most important features, while the actual question of a sleeping-sickness camp will be referred to later. Near the Cape itself there is a small town, Waslunga, which is very close to an extensive mangrove swamp, and here *Glossina palpalis* was caught. This village ought certainly to be removed further from the swamp, chiefly because of the continual intercourse that exists between it and Bathurst.

Bakau is a small village near Government House, and is one of the few exceptions found in the Colony where the village well is enclosed by dense thick bush (fig. 1). This village, and the surrounding bush, is a haunt of all forms of noxious insects. In the enclosure of the European house in which I was quartered when at Bakau, the following flies were caught:—*Glossina palpalis*, *Stomoxys calcitrans*, *Lyperosia minuta*, and *Haematopota decora*; while one small species of *Tabanus* was also seen. From my pony I obtained the following ticks:—*Amblyomma variegatum* and *Hyalomma aegyptium*. Extensive clearing around this village is strongly to be recommended; it will not be necessary to cut down the large trees, but only the thick undergrowth to a height of about 10 feet, so that the sun's rays may have full access to the soil. *Glossina palpalis* was also caught at the following places:—the bridge crossing Oyster Creek, Camelo Bridge, two places between Jesswang and Taranakunda, Bakotti Bridge, Newcastle, and the bridge near Jesswang (*see* Map). Although there is extensive clearing in this whole region, large clusters of bush, with consequent stagnant water or surface moisture, have been left, and these are all harbours and centres of distribution for tsetse (figs. 2 and 5). The whole of this region is very flat

Fig. 5.—View near Bakau showing open forest belt with Oil and Borassus palms.

and fertile (fig. 6), and consequently there are numerous villages; yet in spite of the frequency of *Glossina palpalis* at present, it is not too much to say that, with some judicious clearing such as that recommended for Bakau, the whole area could be very easily freed from this pest. No tsetse occur, so far as I

Fig. 6.—View at Cape St. Mary, to show the open nature of the surrounding country.

could ascertain, in the vicinity of the coast bluff, where it is proposed to build the new European quarters, and without interfering with the Rifle Range which exists there at present, adequate accommodation is available for a sleeping-sickness camp without in any way jeopardising the military occupation, or affecting satisfactory communication with Bathurst.

(*b.*) Kerewan to MacCarthy Island (North Bank).

The town of Kerewan is situated on the Suarra-Kunda Creek, which is navigable for ocean-going vessels up to this point. The whole creek is fringed with dense mangrove growth and swarms with *Glossina palpalis*. The town itself lies about a mile away from the creek, in an open clearing. The country for several miles around is completely denuded of bush and is extensively cultivated. On my visit here, a large Norwegian steamer was loading ground nuts at the Kerewan Wharf. The captain informed me that although he had been there for four days, he had not seen a single mosquito; but on the other hand, tsetse were very troublesome, invading even the saloon below. Practically no clearing had been done in constructing the wharf; in fact, both bow and stern of the vessel were stuck fast in the mangrove thicket.

From Kerewan the main north-bank road diverges from the river and passes through Saba, Salikeni, Nja-Kunda, No-Kunda to Illiassa. The whole of this area is extensively cleared for cultivation, the ground is sandy, and the surrounding country is open and park-like in character, and in no way suited for

tsetse haunts. Near No-Kunda there is a small area of thick, low scrub, but the town itself stands in an open clearing, while between No-Kunda and Illiassa there is a long swamp which, at the time of my visit (March 10th), was practically dry, except in one place where the crossing is muddy and the water about two feet deep. This swamp is an extension of two creeks, the Katchang Bolon and the Tunku Bolon. During the wet season, the overflow of the river would cover an area of considerable extent, and it is worthy of note that *Glossina palpalis* was afterwards caught at the mouth of the Katchang Bolon, so that it is more than probable that the range of this insect would extend in the wet season practically up to Illiassa. None were seen, however, on March 10th, when a strong Harmattan was blowing.

At all the towns mentioned there were large herds of cattle, numerous goats, and not a few donkeys. Conversation with the headmen of the towns failed to elicit much reliable information either with regard to biting flies, sleeping-sickness, or diseases of cattle, but an attempt was made to find out the native names of the various blood-sucking insects. Some consideration of this will, however, be given in detail later. Elephantiasis is very prevalent in nearly all these towns.

Beyond Illiassa, the character of the vegetation changes somewhat. The first part of the way is the main road to Kubendar and is well cleared, but near Yalloll the road branches off to Farafeni and consists simply of a bush-path, first through thin low scrub and later through thin bush. Between the two Foulah towns of Yalloll and Fula Farafeni, the bush is thin and stunted, consisting of deciduous trees with little undergrowth, and is a haunt of *Glossina morsitans* (fig. 7). Wherever there are Foulah towns, there one sees large herds of cattle, but little cultivation and consequently little clearing. The head-man of Farafeni

Fig. 7.—Path through thin deciduous bush between Yalloll and Fula Farafeni to show a typical *morsitans*-haunt.

complained most bitterly of a great loss of cattle during the past two years, and his description of the disease was extremely suggestive of trypanosomiasis. When questioned about tsetse, he denied their occurrence actually in Farafeni, but stated that they were to be found at Beretto towards the end of the rains, which is not at all improbable.

The road from Farafeni to Ballangar passes through Sukotto, Kattaba, Dipakunda, M'Palen, and N'Geyen Sanjal. Between Kattaba and Dipakunda several tsetses (? *G. morsitans*) alighted on my pony's neck. The bush in this part is exactly the same as that between Yalloll and Fula Farafeni. In the camp at Dipakunda, a tsetse, almost certainly *G. morsitans*, settled on my arm, but unfortunately I did not manage to secure it. *Tabanus taeniola* also exists here, and one *T. ditaeniatus* was seen; one flea (*Ctenocephalus felis*) was obtained.

Between Dipakunda and Ballangar lies N'Geyen Sanjal. The road runs through thin bush and over two iron-stone ridges. About a mile from N'Geyen Sanjal there is a gully, which obviously contains water in the wet season, while about three miles further on there is, surrounded by a laterite ridge, a swamp (dry when visited on March 13th), which must also be covered with water during the rains. At Ballangar a specimen of *Tabanus ditaeniatus* was caught on the pony at noon, and at 6 p.m. a tsetse, almost certainly *Glossina morsitans*, alighted on the writer's leg in camp. The Ballangar wharf is about three miles from the native town and is connected with it by thin bush; it is a very important loading place for ground nuts, and several European merchants are stationed here in the dry season. The clearing is quite inadequate and *Glossina palpalis* is frequently met with. From Ballangar wharf to Kauur, the country was one large dry swamp, which must be practically impassable in the rainy season. In the dry season the mud is baked hard and cracked, and consequently one would not expect to find tsetse at this season of the year, but, in the wet season, it is extremely probable that *G. palpalis* is to be found the whole way between the two wharves. Kauur wharf lies about two miles from the native town; there is little or no clearing, and the jetties are simply built out into the river and are fringed on both sides by mangroves. I took the opportunity of going out on the river in a rowing boat, but although several *G. palpalis* and *T. taeniola* were flying around, I was unable to secure specimens. One of the French traders here told me that tsetse were very troublesome when the natives were loading, and that they even invaded the European houses nearly half a mile from the river bank.

Leaving Kauur, the road passes through thin bush the whole way to N'Jau. Not far from N'Jau is the small town of Bulghurk, and here one *Glossina morsitans* was seen on the pony's neck. From Bulghurk to N'Jau, the road runs practically along the French boundary. At N'Jau *Tabanus taeniola* was caught on the pony's neck at 4.30 p.m., while at 6.15 p.m. *Glossina morsitans* was captured biting the writer's arm in camp.

Between N'Jau and Tento there are a number of small villages, notably Leba, Amodi, Panchang, and Porli. Leba is about 1½ miles from the Nianija Bolon, one of the largest creeks on the north bank of the River Gambia. From Leba to Tento, the road runs nearly parallel with the creek at distances varying from 1½ to 2 miles from it, while immediately after Panchang a small dry water course

is crossed. Particularly to be noticed on this day's march was the large number of Borassus palms, which so far had hardly figured in the vegetation. Tsetse were seen at Amodi, Panchang, and Porli, and all seemed to be *Glossina morsitans*, although, from the nature of the country and the close proximity to the creek, one would rather expect to find *Glossina palpalis*. One specimen caught on the pony at Panchang at 8.15 a.m. was *G. morsitans*, as also were others caught at Tento in the stable at 12.30 p.m. so that in all probability the others were also *morsitans*. *Tabanus taeniola* was also caught in the stable at 11.30 a.m.

Between Tento and Ker Sidi there was a dried up swamp, and across this I rode with the Commissioner at 5.30 one evening. Although we had to walk our horses across the swamp owing to the broken nature of the surface, no biting flies of any kind were to be seen. It was two days after full moon (March 24th), and when I was riding back between 9.30 and 10 p.m. the pony showed signs of irritation, became restive and kept swishing his tail about vigorously. As we had had a very bad encounter with a swarm of bees a few days previously, and, as there was a distinct buzzing sound, I became apprehensive. The buzzing increased, and numerous flies made repeated darts at my head, neck, and hands; I managed to secure two of these gorged with blood. The pony, by this time, was well-nigh uncontrollable and I made for camp. On examination the two flies proved to be *Glossina morsitans*. There could not have been fewer than 100 of them, and their persistence of attack, and the buzzing sound emitted, were more suggestive of Hymenoptera than tsetse.

Immediately after leaving Tento, the road runs parallel with the Nianija Bolon at a distance of less than 100 yards from it. The whole way to Niani Bantang, where the creek is crossed by a "crinking" (interwoven strips of bamboo) bridge, the country is fairly open and extensively cultivated, but the banks of the creek are covered with dense bush and high shady trees. There were a few dry places, but the greater part of the Bolon still retained water. I halted for a time at the Nianga crossing, but on or around the pony (which generally acts as a tsetse decoy) only *Stomoxys nigra* was found, apart from other non-blood-sucking Diptera, which are irritating to horses and cattle, and very annoying to man.

From Niani Bantang to Jalo Kunda the road passes through open thin bush. The headman of Niani Bantang informed me that both tsetse and large Tabanids swarm there during the rains, but in the dry season are extremely rare. From Jalo Kunda to Gassan, the road is through thin bush and bamboo, the latter predominating where there is a preponderance of laterite and little or no telluric moisture. The camp at Gassan is close to a swamp, and a species of Anopheline, *Nyssorhynchus pharoensis*, was caught in one of the houses at 10 a.m.; this was the first mosquito seen since leaving Bathurst.

The town of Gassan being close to the river, I took the opportunity of examining a portion of the latter to see to what extent anyone, rowing close to the river bank, would be subject to attack by tsetse. For this purpose, I got a native canoe, or dug-out, and proceeded to Wassu, a small wharf about three miles further up the river, always keeping within 50 yards of the bank. The

vegetation on the river bank was very dense and overhung the water. It consisted chiefly of palms, pandani, ferns, and thick bushy shrubs (fig. 8). No

Fig. 8.—View on the River Gambia beyond Barijali showing the dense nature of the vegetation which consists of Ferns, Palms, Pandani, &c., and is a typical *palpalis*-locality.

sooner had we pushed off from the bank than numbers of biting flies assailed us. The following TABANIDAE kept hovering round, *Tabanus secedens*, *T. fasciatus* and *T. taeniola*, but as movement is very restricted in this type of canoe, none were actually caught. It was different, however, in the case of tsetse; these simply swarmed round and attacked persistently. After a number of specimens were secured, no further attempt at capture was made, and it was with difficulty that we managed to guard against too many bites. A ground-nut steamer was being loaded at Wassu, and here tsetse occurred in such numbers and so persistently darted from one person to another that a distinct humming sound was to be heard. After a very short stay, we pushed off and were followed by a large number of these insects, but by the time we had reached 70 to 80 yards from the bank, all had disappeared. On returning to camp at 1.30 p.m. we caught one *Stomoxys nigra* and one tsetse in the stable.

The opposite bank of the river bore very little in the way of vegetation; clusters of ferns and a few palms were scattered about. At 2 p.m., we crossed over to this side and moved slowly up-river to opposite Wassu, again keeping within 50 yards of the bank the whole way. The only Tabanid caught was *Tabanus taeniola*, but tsetses were quite as troublesome as on the other bank; two were caught *in coitu* at 3.30 p.m. and must have flown from the bank, some 50 yards, in this attitude, as they were thus seen approaching the canoe some yards off.

The identification of the tsetses, secured on these two canoe trips, was a matter of some difficulty. It was well-nigh impossible to assign them to any definite species on the basis of external characters alone. In some respects they resemble *G. tachinoides*, *e.g.* in their small size and in the extent of the pale markings on

the abdomen, but the dark bands are not so sharply defined as in this species nor is the quadrilateral area on the first segment so definitely marked. Professor Newstead* has very recently made a study of the male genital armature of the various species of *Glossina*. In his paper, page 23, he points out that the form of the inferior claspers distinguishes the two species, *palpalis* and *tachinoides*. Dissection of two of my specimens showed that the inferior claspers corresponded with the form described by Newstead for *G. palpalis*, and on the assumption that this is a specific character, I determined to relegate them to that species. At the same time, it must be borne in mind that they are far from typical *palpalis* as regards their external markings, and apart from the question of a local race they almost justify the establishment of a new variety.

The road from Gassan to Kantaur lies through thin bush. Around Kantaur, which is a fairly large town, there is extensive cultivation and consequently a large amount of clearing. Shortly after leaving Kantaur, the road passes over a high rocky laterite plateau, covered with clusters of stunted bamboo growth. The descent to Manna is very steep and rocky. No blood-sucking insects of any description were seen on this trek, nor does the type of country seem in any way adapted for them.

Fig. 9.—Beach at Lamin Koto, opposite MacCarthy Island.

The time at my disposal being short, I found that it would be impossible for me to continue onwards on the north bank, so I thought it advisable to cross over to MacCarthy Island and work towards Bathurst on the south bank, especially as the Government steamer does not proceed further up-river during the dry season. For this purpose I pushed on to Lamin Koto, the north-bank ferry for MacCarthy Island. As the formation of the bank at Lamin Koto is very typical of many wharves on the upper river, I have given a photograph of it (fig. 9), and a short description may be useful and suggestive. The soil, for

* Bulletin of Entomological Research. Vol. II. Part I. pp. 9 to 36.

a considerable distance from the river, consists of thick mud, which, in the dry season, is baked hard and much cracked. Numerous large trees and a small amount of bushy scrub occur in the vicinity of the river, and there are also a few scattered Oil-palms. At the actual crossing, a certain amount of clearing has been done, but this is by no means adequate, inasmuch as sufficient bush has been left to form an admirable tsetse refuge. This applies to nearly all the ferries on the river. At almost any hour of the day, numbers of natives with goats, sheep, donkeys, cattle, etc., may be seen waiting for canoes to ferry them across, and all these are subject to tsetse attacks.

The camp at Lamin Koto is situated about a quarter of a mile away from the river bank, but during the wet season this whole area is inundated with water and it is possible to row close up to the camp. The importance of this will be seen later in a discussion on the possible breeding-grounds of *G. palpalis*.

(*c*.) MacCarthy Island.

MacCarthy Island lies about 150 miles from Bathurst; it is, roughly, 6 miles long and 1½ miles at the widest part, near the middle; from this it tapers to both ends. The main branch of the river is on the north side, and even here it is only about a quarter of a mile wide, while the stream separating the island from the mainland on the south side is only about 200 yards in width. To the north bank there is only one crossing; namely that to Lamin Koto, but to the south there are two, one at the east end to Boraba, and one at the west to Faraba; both the latter are simply narrow clearings in dense bush. The whole island is fringed by thick bushy undergrowth, except where the factories are built. The interior is very low-lying, and in the wet season is covered with water, being extensively used for rice farming. Various types of vegetation are met with on the island, from thick bush to thin scrub, while palms also occur in places, but there are few trees of any great size. There is only one small native village, situated near the centre of the island, close to the European quarter. This island is very important, inasmuch as it separates the "Upper" river from the "Lower." Ocean-going steamers ascend the river to this point even in the dry season. All the produce of the upper river is brought down to this island in schooners and deposited until the large steamers call and take it direct to Europe; consequently it is the most important commercial depôt in the colony, apart from Bathurst, and European representatives from all the trading firms are stationed here during the dry season. The Government steamer also calls weekly in the dry season, and fortnightly during the rains. There is a large Government House, used chiefly by travelling officers, and a native hospital and dispensary. Quite recently, a European hospital has been built, and a medical officer has since been stationed there. Between Government House and the Boraba crossing, *Glossina palpalis** was caught, while, in a canoe, at the crossing itself both *G. palpalis* and *Tabanus taeniola* were found. On my second visit to the island, while in the Government steamer, which was

* The *Glossina* caught at MacCarthy Island show the same markings as those described from Gassan and Wassu.

lying about 100 yards from the wharf, I caught *Glossina palpalis* between 5 and 6 p.m.; also while we were passing the south end of the island in the steamer, at a distance of about 50 yards from it, *G. palpalis* flew on board one morning about 8 a.m.

Auchmeromyia luteola, the adult of the floor maggot, was very common in Government House, and *Pyretophorus costalis* was also caught. Sleeping-sickness is not uncommon in MacCarthy Island, and this, added to the fact that there is a large European settlement here, makes it absolutely imperative that something should be done to effect at least a diminution in the number of tsetses in the island.

(*d.*) MacCarthy Island to Tendaba.

After crossing the river at the west ferry in canoes, we found the country very open the whole way to Faraba. Between Faraba and Patchari there is an extensive swamp which, even in March, retained water in some places. Rice is grown here only at the end of the rains. Patchari is a town of small size: Borassus palms are a marked feature in the landscape. Parts of the road are rocky, and bamboos occur in considerable quantity. Three species of *Tabanus*, namely *taeniola*, *laverani*, and another, probably new, were caught round the village well, while water was being drawn for the cattle. Mosquitos (*Culex decens*) were very troublesome at night, but the reason for this was not far to seek. Rest-camps in the Gambia consist of a number of houses built of "crinking," the local name for interwoven strips of bamboo, and thatched with grass, the whole surrounded by a fence of the former material. As these camps are not used during the wet season, it is not necessary to guard against rain; consequently this open lattice work adds considerably both to light and ventilation, and therefore minimises the chance of mosquitos lurking about. At Patchari, however, the walls of the principal rest-house, in addition to having the usual crinking, are also covered with mud, making the house very much darker, and it is worthy of note that in all houses in which this method of construction has been adopted, mosquitos were found. Now, the chances of these insects breeding in the camp are very remote, as the only water in the camp is brought, on the arrival of the European, in pots belonging to the village, and these are most sedulously guarded, and removed immediately after the camp is vacated. It is more than probable, therefore, that the mosquitos invade the camp after they are hatched, and that the dark, moist places, caused by the mud walls, serve as a retreat. Although in this actual instance only Culicines were caught, still there is no reason why Anophelines might not also occur. Consequently it is inadvisable to use mud in the construction of houses, if it can be avoided. This feature was more noticeable at Brikama where 32 mosquitos, all *Culex decens*, were caught between 10 and 10.30 a.m. on my arrival in camp. Two of the houses in this camp were made of mud. One *Tabanus*, probably a new species and similar to that caught at Patchari, was obtained near the well.

From Brikama to Tenenfara (Madina) practically the whole road lies at the foot of a bamboo-covered, laterite ridge, which forms the eastern limit of an extensive swamp. Even at the end of March, there was a considerable amount

of water in many places, and large water-fowl were abundant. There is an enormous number of rice farms in the drier parts of the swamp. The road is very sinuous, following the inequalities of the uncertain ridge. There can be no doubt that this is a pestilential part in the rains, and must be a hot-bed of *Glossina* and TABANIDAE (Mangrove flies).* Even at the time of my visit *G. palpalis* occurred in the camp, which is some considerable distance from the swamp, one being seen at 9.30 a.m., while others were found near the watering-place throughout the day. *Tabanus taeniola* was seen in the stable at 4.30 p.m. From Tenenfara to Kudang the country is moderately open, and no biting flies were seen. The small number of flies of any sort was to a great extent accounted for by the excessive heat, the mid-day shade temperature during these days being 104° to 105° F. From Tenenfara to Kudang, the country is covered with thin open bush, and there is a large amount of cultivation; no biting flies were seen. The road from Kudang to Jarreng passes through Fula Kolon, Bamba Kolon, and Gauwa, and thus skirts the edge of an extensive swamp. At Jarreng one large *Tabanus*, similar to those got at Patcheri and Brikama, was caught. From Jarreng to the Sofaniama Bolon, there is simply a small track through thin bush; the creek itself contained very little water, while after that the road passed over a "baked" swamp, consisting of a number of rice fields. One *Tabanus taeniola* was caught flying round the horse in camp at Sukuta at 5.30 p.m. The route from Sukuta to Dassalami passes through a small part of French territory over a rocky laterite ridge. After leaving Dassalami, the end of a long creek, consisting of a large number of rice farms, is skirted. An examination of the bush in the vicinity of the creek failed to reveal any biting flies; in fact, except for one Dipteron, nothing but a large number of honey-bees was seen.

Bureng to Jappeni. Practically the whole of the track from Bureng to Badumi (a small town not shown on the map, but lying about half-way between Jassong and Jappeni) skirts the fringe of an extensive swamp in which stagnant water occurs in several places; large clusters of dense bush and Oil and Borassus palms are abundant at several places on the route. *Glossina morsitans* alighted on the pony's neck while I was at Badumi; three were to be seen on him at one time while standing near the village well. Between Jassong and Badumi the country is such as might lead one to expect *Glossina palpalis*: in fact, it is more than probable that it does occur here during the rains. From Badumi to Jappeni the road passes through thin bush, typical *morsitans*-country. *Auchmeromyia luteola* was obtained at Jappeni.

From Jappeni to Soma the road passes through two small towns, Buiba and Karantaba. Before reaching the town of Buiba the head of the Buiba Bolon is crossed; around this ridge there is dense bush and numerous oil palms. The approach on either side is a well shaded avenue, and here *Glossina morsitans* occurred in greater numbers than in any other part of the journey. Close to the town of Buiba there is a large open clearing, and on approaching it we saw an enormous number of dog-faced or Guinea baboons (*Papio sphinx*) of all sizes.

* As there seems to be a certain amount of misunderstanding in some quarters with regard to what are actually included in the term "Mangrove flies" I may take this opportunity of pointing out that this term is collective for TABANIDAE, large and small, and does not include such insects as *Cordylobia anthropophaga*, the maggot-fly, which does not bite.

The road ran through the middle of this area, and on my arrival the baboons scattered to both sides. While passing over the ground recently occupied by them, the pony was badly attacked by tsetse, which had evidently followed the baboons to the open ground: many of them were gorged with blood and could fly only with difficulty. On three occasions during my tour in the Gambia, have I witnessed this phenomenon: namely, the predilection of *Glossina morsitans* for following a troop of baboons, even in the heat of the day, from their shady retreats into the open. At Buiba, the following blood-sucking flies were captured:—*Glossina morsitans*, *Tabanus taeniola*, and *Tabanus ditaeniatus*, all around the pony between 10 a.m. and 12 noon.

At Soma, *Glossina morsitans*, *Tabanus taeniola* and *T. par* were caught between 3 and 4 p.m. The road from Soma to Kaiaff lies through open bush, but there are two swamps containing large pools of stagnant water: these are fringed with dense bush and seemed likely places for *Glossina palpalis*. None, however, were seen, but *G. morsitans* occurs all along the route.

I spent a day at Kaiaff and examined the whole of this vicinity. Near the swamps, there are numerous rice farms surrounded by thin bush and scanty undergrowth, and here *G. morsitans* exists in considerable numbers. Other blood-sucking flies caught at Kaiaff were:—*Tabanus taeniola*, *Tabanus ditaeniatus* and *Tabanus par*, all very abundant in the stables. Between Kaiaff and Mandina, the country is open and almost completely cultivated the whole way. At Generi, a small town about 3 miles from Kaiaff, *Glossina morsitans* was caught, but at Mandina the only blood-sucking fly seen was *Tabanus taeniola*. From Mandina to Quinella, the road lies through cultivated country with thin bush, but there are two swamps both surrounded with thick vegetation and high shady trees. Not far from Mandina, a single specimen of *Chrysops longicornis*, the only one seen during my tour, was obtained.

From Quinella I went to Tendaba, a landing-stage on the river about three miles from Quinella, to await the Government steamer from Bathurst, as by this means it was possible for me to examine the Bintang Creek. At Tendaba I remained for two days and so had an opportunity of finding out more exactly the facts as to the occurrence and habits of blood-sucking flies at such landing-stages. There are no European factories here, but it is a recognized calling place for launches passing up and down the river. Considerable trade is, however, carried on by the natives, and a large quantity of ground nuts is shipped here on board schooners for Bathurst. The landing stage itself is at the end of a laterite escarpment, and consequently the bush in the immediate vicinity is very sparse, but the bank of the river, except for a clearing of less than 100 yards, is fringed with mangroves. The following blood-sucking flies were abundant:—*Glossina palpalis*, *Stomoxys nigra*, *S. calcitrans*, *Lyperosia minuta*, *Tabanus taeniola* and *T. ditaeniatus*. *Glossina palpalis* swarmed practically the whole day, but were not so numerous between 1 and 3 p.m. At no hour of the day from 7 a.m. to 6.30 p.m. was it possible to sit down without being persistently attacked by these insects, and when one did sit down it was necessary to have a boy with a "horse-tail" keeping a sharp look-out, especially round one's legs and ankles. *Stomoxys* and *Lyperosia* reserved their attentions for the horses, but were not very troublesome until after 3 or 4 p.m., when they were a source of great

irritation ; all parts of the pony were attacked, but more especially the pasterns. This is due in great part to the fact that there are no muscles in this region capable of causing a twitching of the skin. The number of these insects may be gauged by the fact that, using a glass-bottomed box 1½ inches in diameter, I frequently caught four and sometimes five by simply placing the box over such a group. The great abundance of *G. palpalis* at such places being necessarily a source of danger, some considerable outlay for clearing measures is surely justified.

(*e*.) Bintang Creek.

This creek opens into the River Gambia, about 25 miles from Bathurst, and after a short but very tortuous course runs practically parallel with the river. Its length in British territory is, roughly, 50 miles, and it is navigable all the year round for launches, drawing 6 ft. of water. At its mouth it is nearly a mile in width, but it gradually narrows until at Sandeng it is only about 50 yards wide. The tidal influence is marked throughout the whole course, and, as in the case of the main river where this occurs, the banks are clothed with a dense growth of mangroves from end to end, except perhaps where villages are situated, and there sporadic trees of various kinds have sprung up. The country is very flat in this region, except at Bintang (fig. 10), where the town of that name is

Fig. 10.—Town of Bintang, on the creek of the same name.

situated, and where there is a slight elevation of the bank. The only other town of any size is Kansala ; fig. 11 shows the wharf and landing stage of that town. This view is typical of all the landing stages on the creek ; it shows how these are constructed and to what extent clearing has been done. Only sufficient mangroves have been cut down to clear a space on which to build the wharf and leave a small open part on each side for canoes. Apart from *Glossina palpalis*, the only blood-sucking fly seen was *T. socialis*, and it is noteworthy that only in

the Bintang Creek was this species caught during this tour. One specimen was obtained at Kansala and another at Sandeng. *Glossina palpalis* occurs, one may almost say with certainty, along the whole creek, but for the present, I have recorded on the map only actual localities where they were seen to fly on board, or where they were caught on shore. The mere fact of their being seen and caught at all times of the day and at all places on board the launch does not in itself justify the conclusion that they are as plentiful at one place as another, because, after flying on board, they may remain hidden for some time and re-appear near a place which *might* be free from them. Specimens were obtained on shore at Bintang, Kansala, Jarrol and Sandeng—the only four places where the launch remained long enough for one to go ashore to collect. A few other places I have indicated on the map, but there is little doubt that many more places might be with equal certainty included as haunts. It would be better,

Fig. 11.—View of Kansala Wharf, to show the character and extent of clearing at the wharves in the Bintang Creek.

however, to have actual data before committing oneself to any sweeping assertion. The trip in the Bintang Creek served to bring out and emphasise several points at which I have hinted before, but which, up to now, did not present themselves in so concrete a form. His Excellency, the Governor, Sir George Denton and party, including the Gambia Company of the West African Frontier Force, were touring on the south bank of the river at this time and had occasion to cross the creek. For this purpose it was necessary for the Government steamer to go to Sandeng to transfer the party to Jarrol. At Sandeng there is a small jetty similar to that at Kansala (fig. 11), but at Jarrol the steamer is simply tied up alongside the bank. Now I have already stated that at all these places *Glossina palpalis* abounds and that the bush, in this case chiefly mangroves, is cleared only sufficiently to effect a landing. The risk, therefore, in transferring some 500 men under these conditions, is necessarily great, and at least

to minimize this, some attempt should be made to clear an area so that embarkation might be made possible without, as at present, an accompanying swarm of tsetse.

The Government steamer, the "Mansahkillah," has two decks, the lower for native passengers and crew, and the upper for Europeans. With the exception of one cabin and saloon on the upper deck, all the sleeping accommodation is below. During this tour in the Bintang Creek, *Glossina palpalis* swarmed in all parts of the vessel, not being restricted to the lower deck to so great an extent as one sees on the stern-wheelers which ply on the Niger. Never before have I seen *G. palpalis* in such numbers, and even on the upper deck saloon they were so troublesome that we had to have recourse to mosquito boots to protect our ankles. Though not to the same extent, this state of affairs obtains in many parts of the river, and the fact that a former master of this vessel died from sleeping-sickness, contracted on the Gambia, must not be overlooked. For this reason I should strongly recommend that every cabin and saloon be made mosquito-proof with wire gauze. As a marked contrast, from this point of view, I add a photograph (p. 226) of another Government steam-launch, the "Rose," which was fitted up for surveying purposes by Lieut. Spicer Simson, R.N., and which has been made mosquito-proof in the after part—a most admirable arrangement.

A predatory spider, *Plexippus paykulli*, Aud., of the family Attidae, inhabits the "Mansahkillah" in large numbers. These do not spin a web but conceal themselves in dark corners, cracks, or crevices of the vessel, and dart suddenly on their prey. Although *Glossina palpalis* was most abundant, still, there were other non-biting diptera present in the saloon, but it was observed that these spiders ignored the other forms and devoted their whole attention to *G. palpalis*, stalked them, and eventually captured not a few. The attack was usually made from the rear, but was occasionally frontal, the spider always attempting to pin down the wings. When this attempt failed, the tsetse, by a rapid movement of the wings, generally managed to escape, but when once the spider got a fair hold, it hung on tenaciously sometimes for over an hour, at the end of which time the tsetse, though not actually dead, was in a state of collapse, at least in the case of those under observation.

A very marked case of the effect of colour of clothing, in attracting or repelling *Glossina*, occurred during this trip. My companion, who in the earlier part of the day was wearing a white coat, and who was continually attacked by *Glossina* only in the legs and ankles, had occasion to change into a black coat. Soon after, he complained of being bitten on the back and arms, and at first thought that this was due to an increasing number of *Glossina*. After again changing his coat, he noticed that the bites on his back and arms decreased accordingly, and, to test the effect of this change of colour, he wore first one and then the other. In the same space of time, namely 10 minutes, I observed that whereas fifteen *Glossina palpalis* settled on the black coat, only two alighted on the white. The reason why one's legs and ankles are the chief points of attack is that the flies alight and settle unobserved for a time under the seat of the chair or under the table, and then dart quickly out to the nearest unprotected part. It is now known that *Glossina* can, and does, bite through moderately thick

clothing, and very easily through woollen socks, so that in tsetse country the ankles should be well protected by some form of top-boot, *e.g.* mosquito-boots, or putties, but on no account should "shorts" be worn, as they render one very liable to bites behind the knees.

A third point in the habits of *Glossina*, as noticed on other occasions but emphasised during the Bintang tour, is the fact that movement has a decided attraction for tsetses. It is a matter of every day observation that, even in a place where tsetse are abundant, if everyone remains perfectly still few if any tsetse will leave their hiding places and come out to attack, but numbers will be lured from their retreats by any person walking slowly backwards and forwards. The same condition of affairs obtains in the case of cattle. What is more surprising is the fact that very few tsetse fly on board a launch when it is at anchor, even when it is moored alongside the bank at a tsetse-haunt. As soon, however, as it gets under weigh, they immediately swarm on board, flying even a distance of 100 yards in pursuit.

The essential points observed during my journey by launch to MacCarthy Island have already been referred to in connection with the vegetation on the river banks, so that it is necessary here to give only such records of blood-sucking flies as have not yet been noted.

South end of Elephant Island :—
Glossina palpalis.
Tabanus laverani.
Ballangar :—
Glossina palpalis.
Barijali :—
Glossina palpalis.
Tabanus taeniola.
Near Kai-ai :—
Glossina palpalis.
Tabanus taeniola.
Tabanus biguttatus var. *croceus.*

(*f.*) Niumi Province.

Sika (*see* Map) is a Mandingo town of moderate size and stands in a fairly extensive clearing ; it is situated some distance from the river and is surrounded by dense bush. According to the headman of the town, cattle live well here but horses die off soon after arrival. *Glossina palpalis* occurs even in the height of the dry season (1) in the camp, (2) in the bush separating the town from the river, and (3) in the mangrove swamp fringing the river bank. The people seemed well acquainted with sleeping-sickness, and strongly maintained that nearly every year one or more died from this disease. The first part of the road to Albreda is through thick dense bush, a veritable haunt of *G. palpalis* ; further on, an extensive swamp consisting of numerous rice farms is crossed, and thick bush is again entered before reaching Albreda. This town was formerly a French possession but was ceded to the British in 1857. Up till recently it was an important trading port, but now no Europeans are stationed there. The town

itself is surrounded by bush, and the rest-camp, which is situated about 400 yards from the river, is separated from it by about 150 yards of clearing. In spite of this, however, numerous *G. palpalis* were seen in the camp, but these may have followed the native water-carriers from the village. *Anchmeromyia luteola* was also common in the camp. My pony had been waiting here for me for some days during the trip in the Bintang Creek, and on my return several *Hyalomma aegyptium* were found on it. The road from Albreda to Alijamadu runs parallel with the river bank the whole way, passing through Lamin, Tubab Kolon, and Sita Kunda. The nature of this part of the country may be described as open and park-like in character and there is extensive clearing and cultivation around all the towns and villages. Towards Alijamadu, there are large clusters of thick bush and Borassus palms similar to those described at Cape St. Mary. These may well be *palpalis*-haunts. The headman of this village, who is extremely intelligent, ventured the information that tsetse and large Tabanids may be seen here even in the dry season, but are much more abundant during the rains, as also are mosquitos. No horses are kept, and only a small herd of cattle, both, but especially the former, being subject to a form of disease the description of which was very suggestive of trypanosomiasis. I saw one tsetse in the camp, and although not certain, am strongly of opinion that it was *Glossina morsitans*. The dogs in this village seem to suffer badly from ticks, and the following species were obtained: *Rhipicephalus sanguineus*, *Hyalomma aegyptium* and *Haemaphysalis leachi*. Bed-bugs (*Cimex rotundatus*, Sign.) are also very common in the native houses; these the headman brought to me with great pride.

Shortly after leaving Alijamadu for Berrending, a belt of dense bush is encountered; this is immediately followed by an extensive swamp intersected by a creek, which is bridged. This creek is fringed by mangroves, which extend to the river, and is doubtless a *palpalis*-area. From this onwards to Bakkendik, the road passes through dense bush and seems a likely abode for tsetse. Round the town of Bakkendik itself, there is a considerable clearing and abundant cultivation. Quite a moderate herd of cattle was seen here, but the natives say that the rate of mortality is high. After leaving Bakkendik, the road passes through thin open bush and long grass, which is burnt in the dry season, but after about two-thirds of the way to Bintang has been passed, very thick bush with aerial creepers and a dense undergrowth of low palms, ferns, etc., is encountered. This is the top of another creek, and there are numerous pools of stagnant brackish water in the dry season. *Glossina palpalis* was caught here. The rest-camp lies about half way between Berrending and Buniadu. At Berrending, I saw a small girl with marked signs of advanced sleeping-sickness, and the chief, on being questioned, stated that the natives had some months previously assigned this case to "ceeno jankaro"; they do not fear it and the girl lived as usual with her family. The road from Bakkendik to Berrending skirts the edge of a dense forest—the only one in the Colony—already described on page 190. The main route from Berrending to Duniajoe is *viâ* Essau, but there is a bush-path which runs through M'Bollett, and as this traverses the outskirts of the forest, I decided to go by it in the hope of seeing *Glossina fusca*, because, if this species does occur in the Colony, it must almost certainly be in this region. The path to

M'Bollett is through a thin plantation of young trees with very little undergrowth; the village of M'Bollett, which is small, occupies a moderately large clearing in this thin forest growth. Shortly after leaving this village a belt of dense bush with an enormous amount of undergrowth, about 50 yards in width, is crossed, while onwards from this the vegetation consists of thick low scrub. The village of Jeni Kunda stands in the centre of a large clearing, while, beyond this, the thick low scrub continues to Duniajoe, with the exception of one part, which is intersected by a creek fringed with mangrove swamp where the water ebbs and flows with the tide. The forest behind Duniajoe teems with small game, as was shown by the number of skulls and horns lying about the various compounds. The natives say that it is almost impenetrable in most places, and that hunting is very difficult. From Duniajoe to Essau, the road traversed is for a certain distance, namely to Jeni Kunda, the same as that already described, while, shortly after leaving this town, the dense belt of bush mentioned before is again crossed in a different part. Just after emerging from this belt I saw *G. morsitans* alight on the pony's neck. After this, the bush is thin and open practically the whole way to Essau; about half way, one *Glossina morsitans* was caught on the pony. Just before reaching Essau, a mangrove swamp is passed on the west, while the town itself is also surrounded by mangroves. It is worthy of note here that Todd and Wolbach found that 5·4 per cent. of the population were infected with *Trypanosoma gambiense*—the highest percentage found in any part of the Colony. They have recommended the removal of the town and this is certainly the best advice; if such a drastic step is found to be impracticable, at any rate extensive clearing ought to be done, as the place swarms with *Glossina palpalis*, and there is continual intercourse between this Province and Bathurst, through Essau.

I have discussed the various types of vegetation and the physical configuration of the whole Colony and Protectorate in a general way, but in the case of the part of the Niumi Province visited, considerable further detail has been added. This has been done advisedly because, from the point of view of *Glossina* and trypanosomiasis, this district presents an enormous field for enquiry. In most other parts of the country where *Glossina palpalis* and *Glossina morsitans* exist, there is a fairly definite distinction between the habitats of the two species. This does not obtain to the same extent in Niumi, as is evidenced by the notes and records already given. Here also is the only forest belt in the Colony and the only game reserve of any extent. It may be noted here that all officials of the Colony, who have travelled through this Province, are unanimous with regard to the improbability of taking a pony through it without its being infected with trypanosomes. The natives are all very emphatic that it is useless for them to procure ponies, as these almost invariably die within a year. This was the last district visited by me during my tour; in fact, I left for England four days after finishing this trip, and it may be worthy of notice that, throughout my whole tour in the Colony, my own pony showed no signs of trypanosomiasis, although I did not dose him with mercury and arsenic, a precaution I always took in Northern Nigeria. Yet within a fortnight of my leaving the Colony or, in other words, within a month of the pony's first entering the Niumi Province, he showed

distinct signs of infection and, when examined, was found to be suffering severely from trypanosomiasis, which was most probably contracted in this district. He was brought to England and is now, I understand, in the Veterinary Farm at Camden Town.

Almost the same state of affairs holds good with regard to cattle ; a few may be seen in some of the villages, but in none are there large herds, such as may be seen in the other districts. This is due entirely to the fact that the rate of mortality is so high that the natives will not take the risk of importing them. Sleeping-sickness is also far from uncommon and, as already mentioned, the highest percentage for any village found by the Expedition of 1911 was at Essau, a village on the river bank in this Province. This area, therefore, being well circumscribed, is preeminently suitable for various lines of enquiry. It is practically certain that trypanosomiasis is responsible for the mortality amongst the horses and most probably also amongst the cattle. It is not at all certain, however, that the horses and cattle are infected with the same trypanosome, and further, the mortality amongst the latter *might* be due to a form of piroplasmosis. These points alone would justify the establishment of a temporary laboratory, but in addition to this, the question of reservoirs is an all-important one, and, in this region, ample scope could be found for such work, in fact it is not too much to say that practically every species of animal found in the Gambia, could be obtained here.

We are entirely ignorant of the breeding places of *Glossina* in the Gambia, and no area could be more suitable for such an investigation than the Niumi Province. Consequently, to the Veterinary Surgeon who wishes to study the origin, cause, or treatment of protozoal disease in horses and cattle ; to the Protozoologist who wishes to study the origin and transmission of trypanosomiasis in man ; to the Medical Officer who wishes to follow the course and curative treatment of sleeping-sickness ; or to the Entomologist who is desirous of investigating the habitats, life-history, and bionomics of blood-sucking insects and other arthropods, Niumi Province, so easy of access from Bathurst, opens up unlimited opportunities for research.

VI. Records of Blood-Sucking Arthropods from the Gambia.

The following list of blood-sucking arthropods has been drawn up to include, as far as possible, all previous records, and so render this report complete in this respect up to the date of publication. It will also serve to show how meagre our information on this subject is, in spite of the large number of species which occur in the Colony and their wide distribution, and may help to stimulate others to fill in the numerous blanks which at present exist. The records of *Glossina* made by the author are not included here, as they have already been detailed and may be seen at a glance on the appended map. The other records here given have also been included on the map, when the localities assigned to them have been definite enough to admit of identification. Apart from *Glossina*, however, all the other species collected by the author are included. The generic names here given for the mosquitos are not those assigned to the various species

in the original report on the collection made by the late Dr. Dutton, but are in accordance with the classification adopted at present by Mr. F. W. Edwards, of the British Museum. It is rather remarkable that no HIPPOBOSCIDAE have been recorded from the Gambia, nor did I see a single specimen during my tour.

Family TABANIDÆ.

Species.	Date.	Locality.	Collector.*	Remarks.
Chrysops distinctipennis, Aust.	26.I.11	Jassong ...	Mr. A. N. Foster	
,, ,,	XI.11	MacCarthy Is.	Dr. T. Hood.	
,, *longicornis*, F.	3.IV.11	Near Mandina	—	On pony on road, 7 a.m.
Tabanus albipalpus, Walk.	?	?	?	Type specimen, collected about 50 years ago.
,, *alboventralis*, Newst.	IX.02	Oyster Creek	Dr. Dutton.	
,, *aquilus*, Surcouf.	?	?	Dr. Best ...	Described in 1907.
,, *biguttatus*, Wied.	III.08	?	Dr. T. Hood.	
,, *biguttatus*, var. *croceus*, Surc.	18.IV.11	Near Kai-ai	—	Flew aboard steamer about 11 a.m.
,, *ditaeniatus*, Macq.	25.III.11	Kulari ...	Mr. A. N. Foster.	
,, ,,	1902	Mouth of river.	Dr. Dutton.	
,, ,,	13.III.11	Ballangar ...	—	On horse at noon.
,, ,,	30.III.11	Buiba ...	—	In stable, 3.30 p.m.
,, ,,	31.III.11	Kaiaff ...	—	On horses in the open at 3 p.m.
,, ,,	5.IV.11	Tendaba ...	—	On horse at 2 p.m.
,, *fasciatus*, F.	27.III.11	Kulari ...	Mr. A. N. Foster.	
,, ,,	1908	?	Dr. T. Hood.	
,, ,,	18.III.11	Wassu ...	—	Flew aboard canoe.
,, ,, var. *niloticus*, Aust.	1906	?	Dr. E. Hopkinson.	
,, *gratus*, Loew.	III.1903	Kunchau creek, 175 miles up the river.	Dr. Dutton.	
,, ,,	12.III.11	Dipakunda ...	—	
,, *laverani*, Surcouf.	1906	?	Dr. E. Hopkinson.	
,, ,,	22.III.11	Patchari ...	—	Near well.
,, ,,	20.IV.11	S. end of Elephant Is.	—	Flew aboard steamer
,, *par*, Walker	1902	?	Dr. Dutton.	
,, ,,	30.III.11	Buiba ...	—	In stable, 6 p.m.
,, *socialis*, Walker.	1906	?	Dr. E. Hopkinson.	
,, ,,	13.IV.11	Between Kansala and Sandeng.	—	Flew aboard steamer about noon.

* Where no name is given the species was collected by the author.

Family TABANIDÆ—*continued.*

Species.	Date.	Locality.	Collector.*	Remarks.
Tabanus sufis, Jaen....	19.IX 02	Oyster Creek	Dr. Dutton.	
„ *taeniola*, P. de B.	?	?	Dr. T. Hood.	
„ „	?	?	Dr. E. Hopkinson.	
„ „	?	?	Dr. Dutton.	
„ „	25.III.11	Kulari ...	Mr. A. N. Foster.	
„ „	12.III.11	Sokoto ...	—	
„ „	15.III.11	N'Jau ...	—	On horse at 4.30 p.m.
„ „	16.III.11	Amodi ...	—	
„ „	16.III.11	Tento ...	—	In stable at 10.30 a.m.
„ „	17.III.11	Jalokunda ...	—	In stable at 4 p.m.
„ „	18.III.11	Wassu ...	—	On river in native canoe.
„ „	21.III.11	Boraba crossing to MacCarthy Is.	—	
„ „	22.III.11	Patchari ...	—	Near well.
„ „	24.III.11	Tenenfara ...	—	
„ „	27.III.11	Sukuta ...	—	In stable, 5.30 p.m.
„ „	30.III.11	Buiba ...	—	In stable, 10.30 a.m.
„ „	31.III.11	Kaiaff ...	—	On horse in open, 4 p.m.
„ „	2.IV.11	Mandina ...	—	On horse, 8.15 a.m.
„ „	5.IV.11	Tendaba ...	—	On horse, 9.30 a.m.
„ „	18.IV.11	Between Ballangar and MacCarthy Is.	—	Flew aboard the steamer in numbers the whole way.
„ „	19.IV.11	Near Barijali	—	Flew aboard the steamer.
„ „ var. *variatus*, Walk.	25.III.11	Kulari ...	Mr. A. N. Foster.	
„ ? n. sp. ...	22.III.11	Patchari ...	—	Near village well.
„ „ ...	23.III.11	Brikama ...	—	Near village well.
„ „ ...	26.III.11	Jarreng ...	—	
Haematopota decora, Walk.	2.III.11	Bakau ...	—	On horse.

Family MUSCIDÆ.

Stomoxys calcitrans, L.	25.III.11	Kulari ...	Mr. A. N. Foster.	
„ „	2.III.11	Bakau ...	—	On horse, 4 p.m.
„ „	5.IV.11	Tendaba ...	—	On horse, 4–6 p.m.
„ *nigra*, Macq.	25.II.11	Bakau ...	—	On horse, 4–6 p.m.
„ „	2.III.11	„ ...	—	
„ „	17.III.11	Nianga ...	—	At the ford.
„ „	18.III.11	Gasan ...	—	On horse in camp.
„ „	5.IV.11	Tendaba ...	—	On horse, 4–6 p.m.
Lyperosia minuta, Bezzi	2.III.11	Bakau ...	—	On horse, 4 p.m.
„ „	5.IV.11	Tendaba ...	—	On horse, 4–6 p.m
Glossina palpalis, R. D., var. *wellmani*, Aust.	IX.02	Oyster Creek	Dr. Dutton.	
„ „	III.08	MacCarthy Is.	Dr. T. Hood.	
„ „	III.10	Kaiaff ...	Dr. E. Hopkinson.	
„ „	III.10	Willinghara..	„	

* Where no name is given the species was collected by the author.

Family MUSCIDÆ—*continued.*

Species.	Date.	Locality.	Collector.*	Remarks.
Glossina tachinoides, Westw.	IX.02	?	Dr. Dutton ...	8 specimens caught along the River Gambia.
„ „ ...	?	?	Mr. G. C. Dudgeon.	
„ *morsitans*, Westw.	III.08	Kai-ai ...	Dr. T. Hood.	
„ „	III.08	Bantonding..	„	
„ „	I.10	Ngow ...	Dr. E. Hopkinson.	6 miles from the river.

Family CULICIDÆ.

Sub-family **Anophelinæ.**

Nyssorhynchus pharoensis, Theo.	1902	Bathurst ...	Dr. Dutton.	
„ „	?	?	Dr. Burdett.	
„ „	18.III.11	Gasan ...	—	In camp near a swamp.
Myzomyia funesta, Giles	1902	Bathurst ...	Dr. Dutton.	
„ „ var. *subumbrosa*, Theo.	„	„ ...	„	
„ *umbrosa*, Theo.	„	„ ...	„	
Pyretophorus costalis, Loew.	1902	Bathurst ...	Dr. Dutton.	
„ „	18.III.11	MacCarthy Is.	—	In Government House.
„ „ var. *melas*, Theo.	1902	Bathurst ...	Dr. Dutton.	

Sub-family **Culicinæ.**

Culex annulioris, Theo., var. *gambiensis*, Theo.	1902	Bathurst ...	Dr. Dutton.	
„ *duttoni*, Theo. ...	„	„ ...	„	
„ „ „ ...	2.IV.11	„ ...	Dr. Franklin ...	(See *Culex tigripes*.)
„ *invidiosus*, Theo.	1902	„ ...	Dr. Dutton.	
„ *fatigans*, Wied. ...	„	„ ...	„	
„ *thalassius*, Theo.	„	„ ...	„	
„ *tigripes*, Grandpré	„	„ ...	„	
„ „ „	2.IV.11	„ ...	Dr. Franklin ...	Bred from larvæ taken from casks containing rotting Baobab fibre.
„ *decens*, Theo. ...	23.III.11	Brikama ...	—	Abundant in rest-house.
„ *quasigelidus*, Theo.	1902	Bathurst ...	Dr. Dutton.	
Mansonioides uniformis, Theo.	1902	Bathurst ...	Dr. Dutton.	
„ „	27.III.11	Kulari ...	Mr. A. N. Foster.	
Scutomyia sugens, Wied.	1902	Bathurst ...	Dr. Dutton.	
Stegomyia fasciata, Fabr.	1902	Bathurst ...	Dr. Dutton.	
„ „	IV.11	„ ...	—	In military barracks.

* Where no name is given the species was collected by the author.

Sub-family **Uranotaeniinæ.**

Species.	Date.	Locality.	Collector.*	Remarks.
Uranotaenia albocephala, Theo.	1902	Bathurst ...	Dr. Dutton.	

Sub-Family **Corethrinæ.**

Corethra ceratopogones, Theo.	1902	Bathurst ...	Dr. Dutton.	

Family CHIRONOMIDÆ.

Culicoides sp.	23.III.11	Brikama ...	—	

Family PSYCHODIDÆ.

Phlebotomus sp.? ...	1902	Bathurst ...	Dr. Dutton.	

Family PULICIDÆ.

Ctenocephalus felis, Bouché.	12.III.11	Dipakunda ...	—	

Family CIMICIDÆ.

Cimex rotundatus, Sign.	22.IV.11	Alijamadu ...	—	In native hut.

IXODOIDEA.

Ticks are far from abundant towards the end of the dry season, but are said to be very troublesome at the beginning of the rains. The following were obtained by the author in March and April, 1911.

Hyalomma aegyptium, L.	2.III.11	Bakau ...	—	On horse.
„ „	21.IV.11	Albreda ...	—	On horse.
„ „	22.IV.11	Alijamadu ...	—	On dog.
Amblyomma variegatum, F.	2.III.11	Bakau ...	—	On horse.
Rhipicephalus sanguineus, Latr.	22.IV.11	Alijamadu ...	—	On dog.
Haemaphysalis leachi, Aud.	22.IV.11	Alijamadu ...	—	On dog.

* Where no name is given the species was collected by the author.

VII. Native Names of Blood-Sucking Insects and other Arthropods.

A knowledge of the native names of blood-sucking insects is necessary to anyone who may try to obtain any information with regard to their occurrence, habits, etc., from the natives themselves. It is also essential if any attempt is to be made to instruct the natives in the rôle played by these in the dissemination of disease, a course which I strongly advocate. Finally, a study of such names, which often describe some habit or peculiarity of the insect as observed by them, is often instructive. For these reasons I have tried to collect the various names used by the different tribes which inhabit the Gambia, but of course this list must necessarily be incomplete. I have, however, included it in this report in the hope that anyone who may notice any fault or omission will kindly point such out so that it may be rectified.

—	Mandingo.	Jolloff.	Foulah.	Teucolor.	Jolah. (8)
Sandfly	Bokaro ...	Mutumut		Bokari ...	
Mosquito ...	Susula... ...	Yoi ...	Bodi ...	Bodi ...	
Flea	Jattocolo ...	Fel ...		Fel ...	
Jigger	Jigger	Jigger (6)		Jigger ...	
Tick	Meto	Wetein ...		Kotu ...	
Bed Bug	Dabo ... ... Babar	Mata ...		Nyaki ...	
Lice	Karanko ...	Tein ...		Bamdi ...	
Large Tabanid	Sujolo (1) ... Siti jolo (2) ...	Koss ...	Kaifal ...	Pechu ...	
Small Tabanid ...	Jolo	Koss ...		Pechu ...	
Tsetse ...	Jolo ... ... Congo fin jolo (3) Jolo messem (4)	Koss ... Jolo ...	Lulu ...	Njol ...	
Sleeping Sickness	Ceeno jankaro (5) Kanta bero ...	Heribat (7) Neluan ...	Doingul...	Kaji ...	

1. The jolo of the horse (suo).
2. The jolo of the "siti"—described to me as a "large bush animal."
3. The jolo of the monkey (congo).
4. The small jolo.
5. Both these terms are used by the Mandingoes. "Kanta bero" means "neck stones," *i.e.*, enlarged glands, while "ceeno jankaro" is literally "sleep sickness." It is averred by those who have studied the language that this latter term was not introduced to translate the English phrase, but was used by the natives prior to our introduction of the term.
6. The word "jigger" seems to be universal.
7. These two terms are used by the Joloffs to denote the two stages. "Heribat" is always translated by "the presence of bumps," *i.e.*, enlarged glands, whereas "neluan" denotes the actual lethargic stage.
8. Unfortunately I did not get the Jolah equivalents, but I have included this column so that they may be afterwards added to complete the vocabulary.

VIII. Bionomics of Glossina.

In the Colony of the Gambia, only two species of *Glossina*, namely, *palpalis* and *morsitans* were observed by the author, and the chief points of bionomic importance have been given in more or less detail in the general narrative. It may be well, however, to recapitulate these.

(*a.*) Glossina palpalis.

Haunts.—Wherever mangroves exist one is almost certain to find *palpalis*, but careful search failed to reveal either pupae or empty pupal cases. This is not surprising, as mud is the chief constituent in a mangrove swamp. At the time of my visit to the Colony, the river level was practically at its minimum, and consequently many small creeks were dried up, and areas which would be swamps during the dry season, were baked hard by the sun and much cracked. If, however, as is probable, the chief breeding period is during the rains, the breeding grounds must be removed some distance from the actual river basin, and the tsetse must follow the receding water, as they are seldom found in the regions which would correspond to the water-level during the rains. In addition to the mangrove area, however, there are scattered over the Colony numerous clusters of dense bush with abundant low undergrowth. The soil in these places consists of decaying humus, and is moist throughout the whole year, even in some places retaining a small amount of surface water. These places are always tsetse-haunts, and as there can be little doubt that they form centres for the dispersal of tsetses, it is to these that attention should first be directed when any clearing is contemplated. A good example of this is to be seen at Bakau and elsewhere at Cape St. Mary, a description of which has been given above.

Abundance.—In most places they attack singly, or at any rate, in very small numbers, but occasionally, in certain places, they literally swarm around, and it is with the greatest difficulty that one can avoid being bitten. Cases of this description were noted on the launch in the Bintang Creek, at Wassu and Tendaba; but this is not always an infallible sign of actual numerical excess over other places, being often due to other factors, *e.g.*, movement.

Movement.—It is a matter of almost commonplace observation that tsetse are much more active and pertinaceous in their attacks on moving than on stationary objects, and for this reason, it seems fair to conclude that they rely more on their sense of sight, than on any other, in selecting their unwilling host. In a tsetse-haunt, if one remains absolutely motionless, in the majority of cases, not a single insect will be seen, but as soon as one begins to walk backwards and forwards, they at once dart out to attack. The same is to be observed in the case of horses and cattle. A similar condition of affairs holds good with regard to canoes; if these be anchored or tied up, one is comparatively immune from attack, but as soon as paddling is commenced, hordes of tsetse swarm around; a good example of this was observed at Wassu (p. 202). Even more noteworthy

is the fact that this holds true for large launches and steamers; this was very marked in the Bintang Creek. When the ship was approaching the river bank, swarms of tsetse flew on board, but if the vessel were actually tied up, few if any were seen, whereas as soon as the steamer cast off, tsetse at once renewed their attacks. This must be borne in mind in the selection and clearing of any parts in a tsetse area, such as wharves, ferries, etc., where there necessarily is considerable movement. In the Gambia, for instance, at the wharves which are used for loading ground nuts, there is a continual stream of natives passing to and from the schooners or steamers. This state of affairs furnishes ideal conditions for attack by tsetse.

Range of Flight.—As is well known, *G. palpalis* prefers to remain in the shade and near the ground, preferably in low scrub, and darts out into the open in the full sunlight only when in search of a meal. The maximum distance to which a tsetse will venture into an area with no shade is of great importance in delimiting clearings. Various estimates have been given, but although one has seen tsetse in camps separated from the bush by over 200 yards of clearing, it is not fair to assume that this distance was actually and deliberately traversed in one flight. It is quite possible that these isolated examples followed the natives or horses, a mode of procedure which they often adopt. On one occasion, however, when on board a launch more than 100 yards from the beach, I saw a *G. palpalis* fly on board in the cool of the afternoon, and in view of this and similar observations, 150 yards may be put down as the lowest estimate for clearing, though 200 yards, if possible, should be aimed at.

Effect of Sun.—*G. palpalis*, more than most other insects, is easily killed by heat, and cannot stand much exposure to the direct rays of the sun. When a number of insects of various kinds are transferred from a net into glass-bottomed boxes, prior to going to camp, it is almost invariably found that the tsetse are the first to succumb to the heat; in fact, if one is out for any considerable length of time, it is difficult to keep these flies alive without making a few air holes in the lid of the box and keeping it in a cool place.

Clothing.—There is now no question but that tsetse can, and do, bite through cotton and woollen clothing, and those even if of a thick texture, *e.g.*, heavy tweed trousers. In many cases one has noticed that these insects have a predilection for certain colours, especially black, and a good illustration of this has been cited on page 210. In tsetse-infested areas, the ankles should be specially protected. Putties or leggings worn with riding breeches are ideal, but, as was mentioned before, "shorts" should not in any circumstances be worn. Khaki has many advantages, and of dark colours, is probably one of the least attractive to this species.

Enemies.—The question of the natural enemies of the tsetse is an all-important one, but it is very difficult to get reliable information on the subject. During my tour in the Gambia, I examined the stomach-contents of a large number of birds

whose food consisted of insects, but in no case could I with certainty identify any remains of *Glossina*. As already noted, however, I observed in the Government steamer an Attid spider attack and kill numerous tsetse, and this species of spider seemed to show a distinct predilection for *G. palpalis*, although several other species of Diptera were almost equally abundant. It is very doubtful if this is of actual importance, but, as a fact in the bionomics of tsetse, may be recorded here.

Daily Prevalence.—This species was caught at all hours of the day, but is most persistent and vigorous in the forenoon. From 5.30 to 9 in the morning they are not very troublesome; from 9 a.m. to about 1 p.m. they attain their maximum of activity, while from this time onwards to about 4 p.m. they are much more lethargic. After this period they again renew their activities until dusk.

Reproduction.—As having a bearing on the season of reproduction, it may be noted that two *G. palpalis* were caught *in coitu* on March 18th at 3.30 p.m.

(*b.*) Glossina morsitans.

Most of the facts given for *G. palpalis* hold good for *G. morsitans*, but the following notes will illustrate where these differ.

Haunts.—This species is seldom or ever found in the same regions as *G. palpalis*, but in the Niumi Province, where there is no line of demarcation between the types of habitat, and where they even intermingle, both species are equally abundant, and the actual nature of the bush gives little or no clue as to which may be expected. Apart from this area, as soon as one leaves the river bank, with its mangrove fringe and its accompanying belt of thick bush, and enters the region of thin bush with little or no undergrowth, one may expect to find *G. morsitans*. Wherever, also, there is a laterite outcrop, with consequently little or no surface moisture and very stunted vegetation, one may safely conclude that *G. morsitans* will be found; but if the outcrop is very rocky and bears only thin bamboos, neither species is to be seen. Typical habitats have already been described in this Report, while fig. 7 gives a good idea of an actual locality. The distance which this species will exist away from water has often been commented upon, and in the Gambia, I have captured specimens fully two miles from the nearest pool of water and as far distant from the nearest village well.

Abundance.—This species is seldom found in great numbers, but on two occasions, cited on pages 201 and 207, they occurred literally in swarms and seemed to emit a much more pronounced buzzing sound than similar hordes of *G. palpalis*; in fact, on one occasion, in moonlight, their approach was distinctly suggestive of a small swarm of bees, the pony becoming restive even before they actually alighted on him.

Movement.—The notes given with regard to *G. palpalis* apply equally well to this species, as also do those on range of flight and on clothing.

Effect of Sun.—This species is not so susceptible to the sun's rays as is *G. palpalis.*

Daily Prevalence.—I had not the same opportunity of studying this point in the Gambia, never having remained very long in a *morsitans*-area, but from observations elsewhere and scattered records in the Gambia, I am of opinion that the lethargic afternoon period does not obtain so markedly as in *G. palpalis.* Noteworthy in this connection is the case cited on page 201, when, on a moonlight night, while crossing a dried up swamp about 10 p.m., we were literally attacked by a swarm of quite 100 to 150, whereas, when we were crossing the same place in the afternoon at 5.30, not a single specimen was seen.

Prey.—There can be little doubt that *G. morsitans* attacks man and animals with equal avidity, but the case mentioned on page 207 is worthy of consideration. On this occasion when riding round a sharp bend in the road I came suddenly upon a large troop of dog-faced baboons in an open clearing of considerable size; these slowly scampered away, but left in their train an enormous number of *G. morsitans*, which had evidently followed them from the surrounding bush. They were, in some cases, over 400 yards from shade, and that at practically the hottest part of the day. Never have I seen as many *G. palpalis* so far away from shade at a similar hour. The predilection, if such it may be, of tsetse for monkeys has been noted by the Mandingoes, for they have named these insects "congo fin jolo" or "the biting fly of the monkey." An examination of the blood of these baboons as a potential reservoir of trypanosomes might well repay the trouble. It is not at all evident why the rate of mortality amongst cattle is so high and still higher amongst horses in the Niumi Province. It is certainly not due to an overwhelming excess in the number of *G. morsitans*, but may in part be due to the fact that there is no region beyond the river area to which cattle can be withdrawn in the rainy season, and consequently they have to stand or fall under the full tsetse scourge during this period. The large amount of game confined in this small area may, however, act as a reservoir, and as these form the food supply of the tsetse, the percentage of infective *morsitans* would be relatively high, which might account for the enormous mortality. The same may apply to *G. palpalis* and the large percentage of human trypanosomiasis infections in Essau, for example. At any rate an examination of the blood of such game might well reward the investigator. Another fruitful line of research may be indicated here, namely the part played by *Stomoxys* as a protozooal carrier.

IX. Remedial Measures and Recommendations.

Beyond pointing out that this town is by no means free from mosquitos, it is not my intention to suggest anything with regard to Bathurst, as this is the province of the Senior Sanitary Officer, and as remedial measures are being very

efficiently carried on by the Senior Medical Officer. In view of the recent epidemics of yellow fever, both in Bathurst itself and in other towns on the coast, some drastic measures should be put into effect. The *modus operandi* of such work has been published often enough and is being adopted on a small scale in Bathurst, but the time has now come when further legislation is necessary and also a much larger sanitary staff to cope with these operations.

Sleeping-Sickness Camps.—I do not propose dealing at any length with this subject, but in view of Dr. Hood's minute forwarded to me by the Acting Governor, I feel it incumbent on me to add the following notes. There is considerable diversity of opinion as to the necessity for these camps, but this point will soon be settled by the Senior Medical Officer. If such are to be established, the first consideration is a suitable site. Several factors must be taken into account in this connection, but the predominant one is that of medical supervision. As pointed out to me by Dr. Hood in conversation, the only Medical Officer available for such work was stationed at Bathurst, but since that time another has been posted at the new hospital at MacCarthy Island; consequently, if no special staff be appointed for this work, camps are possible only in the vicinity of these two places. This restriction does not, however, invalidate the main issue, as, apart from it, the two most suitable situations are those just mentioned. I examined the whole area known as the "Cape" and have already given a general idea of its vegetation and insect fauna. I have also stated that there is no reason why a sleeping-sickness camp should not be established here, even if the European residential headquarters be transferred from Bathurst. There is an extensive area available, but as this is of purely local interest and I have already expressed an opinion as to the most favourable site in my report to Dr. Hood, there is no necessity for me again to enter into details. Apart from the question of accessibility to Bathurst and of its being a suitable locality for segregation, it is an ideal place for a laboratory, and work could be carried on there under the most favourable climatic conditions in the whole Colony. As to a second camp in the MacCarthy Island district, I do not think that the island itself is in any way suited for this purpose. As already stated in dealing with this island, there is an enormous amount of bush and a large area is under water during the wet season. *Glossina palpalis* is abundant practically all over the island, and as there is continual intercourse between both sides of the river and the island itself, a camp in this situation would be a source of great danger. For these reasons, any proposal to establish a sleeping-sickness camp on MacCarthy Island should be at once negatived. On the north bank, however, in the vicinity of the town of Manna, there is an ideal area for such a camp, inasmuch as this is removed from the river, and a site could be selected which would not in the least interfere with the main trade routes. Such a camp would be within easy reach of the MacCarthy Hospital where laboratory work could be effected.

Removals.—Dr. Todd has forestalled me in suggesting that the town of Essau should be removed; its present situation is surrounded by mangrove swamp swarming with tsetse at all seasons. A site could easily be selected in the

vicinity, and a clearing made of all bush over an area of 200 yards outside the limits of the town; further, I would suggest that the same should be done with the village of Waslunga at Cape St. Mary.

Clearing.—Much could be done at very little expense to minimise the risk of the spread of sleeping-sickness by some judicious clearing at wharves, ferries, &c. Details of various places have already been given, but the following wharves are of special importance:—Kerewan, Ballangar, Kaur, Kai-ai, Wassu and Tendaba. The following ferries should also be cleared of bush:—Lamin Koto, Boraba, Faraba and Essau. In all these places, the bush or mangroves, as the case may be, should be cut down on all sides for a distance of *at least* 150 yards from the outermost house or store, or in the case of ferries, from the landing-stage. Of a more general nature, but even more important, are Bakau and MacCarthy Island. The nature of the vegetation around Bakau has already been referred to, but I might point out that it is not at all necessary to cut down the large trees but only the undergrowth and branches to a height of 10 or perhaps 15 feet, so that the sun's rays may have access to the soil. This work could be commenced early in the dry season, and the brushwood burnt on the ground cleared, so as to destroy any pupae which might be lurking there. The same applies to MacCarthy Island, but I would suggest that the nearest cluster of bush should not be closer to the new hospital at one end, or to the trading station at the other, than 400 to 500 yards.

Rest-Houses.—The rest-camps (fig. 12) in the Gambia are certainly better than

Fig. 12.—Typical rest-camp in the Gambia.

any others I have seen in West Africa, but unfortunately a few have mud walls. This fact has been remarked elsewhere, and as these camps are not used in the wet season, mud should certainly be avoided in their construction if possible.

Launches and Steamers.—The mosquito-proofing by wire gauze of all saloons and cabins in vessels plying on the river is strongly to be recommended. A very good example of what can be done in this respect at very little expense and without in any way interfering with the utility of the vessel, is seen in the surveying-launch "Rose" (fig. 13).

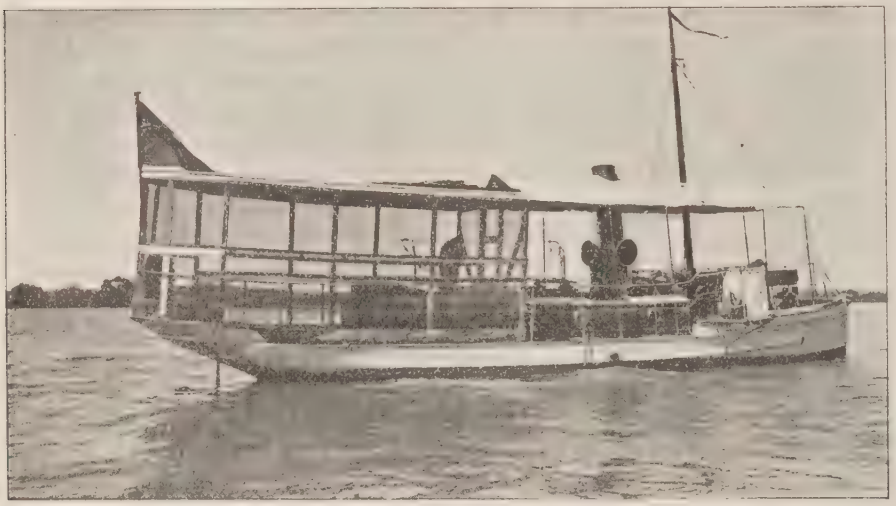


Fig. 13.—Surveying-launch "Rose"—to show effective mosquito-proofing.

Camp for Horses.—There are always a number of horses in Bathurst suffering from trypanosomiasis, and these are a source of danger to the uninfected horses. In addition to this, others are continually being brought down the river to Bathurst. It might be well therefore to have some sort of segregation stable erected in an open clearing about half a mile from Bathurst, where all infected and suspected cases could be segregated until pronounced free from trypanosomiasis. This method has been adopted elsewhere on the West Coast and has been found to reduce considerably the percentage of infected horses in these places.

Instruction of Natives.—It is of the utmost importance that every endeavour should be made to instruct the natives in the connection between certain insects and disease in man and animals, and also as to the means, such as clearing, whereby the number of these insects may be reduced, with a consequent benefit both to themselves and their herds.

In conclusion, I wish to take this opportunity of expressing my indebtedness to His Excellency the Governor, Sir George Denton, K.C.M.G., for the interest he took in this investigation, and for the many facilities afforded me in carrying out the work expeditiously: to Colonel C. W. O'Brien, C.M.G., for his many personal kindnesses and his untiring efforts to further the investigation; to Dr. T. Hood, the Senior Medical Officer, for his hospitality and his suggestions, based on a wide personal experience of the Colony; and also to the other Officers whom I met both socially and officially, through whose advice and help delay and loss of time were reduced to a minimum.

APPENDIX.

Hints for Collectors.

In 1909 a pamphlet of "Instructions to Collectors" was prepared by the Entomological Research Committee and printed by the Colonial Office. Much of what follows is taken from this pamphlet, but several points have been amended and others added. The following hints refer more especially to blood-sucking insects and other arthropods, and are intended mainly for those who have had little or no experience in such work, but who wish to study the insect fauna of their district. The particulars here given emphasise, therefore, the points to which special attention should be paid, and present the more simple methods of collecting, preserving and despatching for examination and identification.

I.—APPARATUS AND GENERAL INSTRUCTIONS.

The following is a list of the more important apparatus required for entomological collecting :—

Nets.—The most serviceable net is that known as the "kite net," the frame of which is in three pieces, the two side pieces being of wood and the top of curved cane : the rigidity of this frame permits of its being used also as a sweeping net. For winged insects the bag of the net may be of the ordinary green gauze : but this should be thoroughly soaked before use to get rid of the starch, otherwise the stiff material will damage all delicate insects : tulle bags last much longer and are softer, but they are a good deal more expensive. It is well to have one or two spare net-bags. The Y which holds the frame should be of brass, the parts being *brazed* together and not soldered, for solder is very apt to give.

Glass-bottomed pill-boxes.—These are indispensable for bringing home fragile insects or such as have easily detachable scales, *e.g.*, moths, mosquitos, &c. The most useful sizes are 1 inch, $1\frac{1}{4}$ inch, $1\frac{1}{2}$ inch and 2 inch diameter. Before using these a small hole should be pierced in the lid by means of a strong pin.

A brass chloroform-bottle.—Chloroform is especially useful when delicate insects, such as mosquitos, moths, &c., have been brought home alive in the glass-bottomed boxes. The chloroform-bottle is constructed so that the liquid comes out in single drops. When it is desired to stupefy an insect contained in a glass-bottomed box before transferring it to the killing-bottle, apply the nozzle of the chloroform-bottle to the small hole in the lid, and sufficient liquid will come out to attain this object without damaging the insect.

Killing-bottles.—These should be made as follows : Into a wide-mouthed bottle put a layer of plaster of paris, from $\frac{1}{4}$ to $\frac{1}{2}$ an inch deep : cover this with small lumps of cyanide of potassium : then add another quarter-inch layer of dry plaster, and cover the whole with a thin layer of plaster moistened to the consistency of cream. As the chemical union of water with the plaster generates heat, the bottle should be heated by placing it in warm water before the last layer is added ; otherwise it is liable to crack. A large prune- or jam-jar is the best for home use, and smaller ones for the field. A large glass tube makes a

very convenient pocket killing-bottle for smaller insects; this can now be obtained in a wooden case, and is consequently not so liable to be broken. If the bottle is used in the field it is essential that it should be three-parts filled with soft, loosely crumpled, absorbent paper (inferior newspaper serves quite well), for not only will this prevent the bottle from "sweating," but it will absorb the juices emitted by many insects, and will also prevent the insects from knocking about in the bottle. Delicate insects should not be put into the cyanide-bottle in the field, but should be taken home alive in the glass-bottomed boxes. In dry localities a killing-bottle will often become weak and ineffective—this may be remedied by pouring into it a few drops of vinegar or soda-water.

A few small *camel's hair brushes* (sizes Nos. 1 and 2), for catching and handling fleas and other small insects.

Curved nickel-plated forceps, for handling pinned insects, &c. Unpinned insects should be *touched as little as possible with the fingers*: they should be picked up either with the forceps or a camel's hair brush.

A pocket lens.—This should magnify about 10 or 15 diameters; higher powers are not so generally useful.

Glass tubes for spirit specimens.—Tubes of various sizes for this purpose are now procurable in wooden cases suitable for sending singly by post, while boxes containing 24 small tubes with a pipette and two camel's hair brushes for this work are now on the market. The corks should be of good quality and waxed to prevent evaporation of the spirit. The ordinary candle used in the tropics is quite suitable for this purpose. Such insects as fleas, bed-bugs, and ticks should *always* be preserved in spirit or formalin.

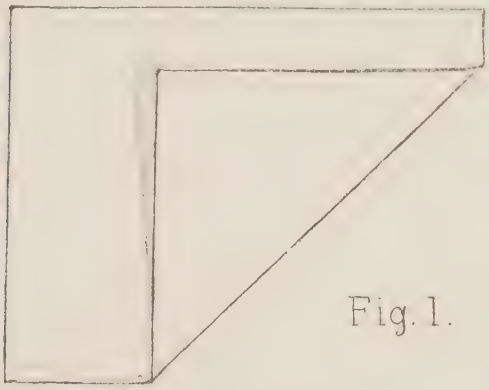
Store-boxes for pinned insects.—If the ordinary deal store-boxes are used, they should be given a good coat of varnish or enamel paint, otherwise they are apt to warp and split during the dry season in the tropics; the tops and bottoms should also be secured with screws, as they are liable to become detached by warping. For transmission by post, cigar-boxes lined with cork-carpet may be used; provided they have been first strengthened by nailing pieces of wood on the *inside* of the short sides (to support the ends of the lid), and by tacking cross-strips on the top and bottom.

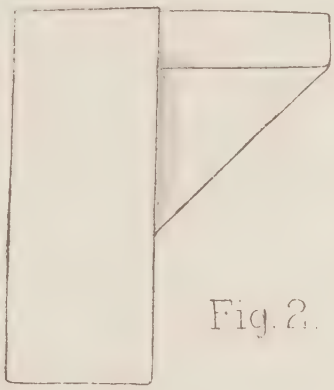
Pins.—In general, it is unnecessary to pin insects for transmission to England, for unpinned specimens travel much more safely. But in the case of Diptera (two-winged flies), pinning is generally the more satisfactory method (for alternative methods, *see* special instructions for Diptera). The pins recommended are those manufactured by D. F. Tayler & Co., the short No. 20 for all Diptera smaller than a house-fly, the short No. 10 for larger ones up to the size of a blue-bottle, and for still larger insects the long No. 16 may be used without staging.

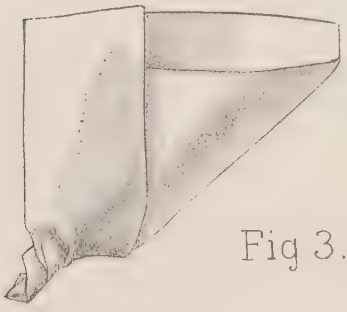
Card discs.—The general employment of these is undesirable, they should only be used for smaller flies, especially those with long legs, such as mosquitos, &c., a No. 16 pin being inserted *near the centre* as a support.

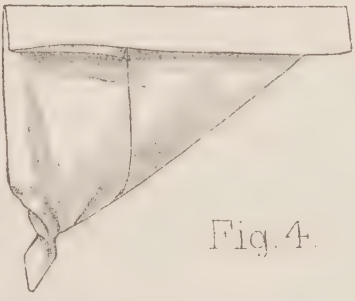
Paper envelopes for Diptera, Hymenoptera, &c.—These are sometimes called "cushion envelopes," and should be made of fairly thin *soft* paper as follows: Take a *rectangular* but not a square piece of paper of suitable size, and write on

it all particulars of capture. Then fold the paper as shown in the diagram (figs. 1 and 2). Place the forefinger of the right hand into the envelope thus made (fig. 2), and with the finger and thumb of the left hand *firmly* twist the apex so that a rigid pocket is formed (fig. 3). Place *one* insect in this, close the open portion by folding over the upper edge, and pass the thumb nail along the folded edge so as to secure the insect firmly (fig. 4). If the paper is too stiff, the cushion will be too rigid and the insect will shake about inside it, with probable damage to the legs and antennae.









Diagrams to illustrate the construction of "Cushion" envelopes.

Strips of *cork-carpet* and *peat* for pinning operations, and for improvising store-boxes.

Chip-boxes or cardboard-boxes are useful for specimens in envelopes.

Labels.—It is impossible to insist too strongly upon the immense importance of giving full data for every specimen captured. The following points should be mentioned on every label:—(1.) Name of locality; in the case of native villages, farms, and so forth, the compass-bearing and approximate distance to the nearest well-known town, river, mountain, &c., should be stated; (2) altitude; (3) date—day, month, and year—thus, 8. V. 09; (4) collector's name; (5) any brief note of interest, such as the name of the food-plant; the name of the host, in the case of a parasite, &c. Longer notes on habits, range, seasonal occurrence, economic

significance, &c., should be kept in a note-book, under a number corresponding with a number on the specimen. In the case of pinned insects, where the brief data are precisely similar for a long series of specimens, a small square of paper of a particular colour may be attached to each insect, and labels giving the data need only be attached to one or two of them. Whenever insects are taken paired, this should be carefully noted, and they should be labelled respectively, "A-*in cop.* with A^1," and "A^1-*in cop.* with A."

Preservation.—Mould may be effectually prevented by rubbing the inside of the box in which insects are pinned with a bit of sponge soaked in ordinary medical (beechwood) creosote, until the cork lining shows through the paper. As an additional precaution, a small quantity of naphthalin should be melted in a test-tube, or iron spoon, and poured into a corner of the box, to which it will firmly adhere. The latter method may also be adopted in the case of boxes containing insects packed in papers or in sawdust, a few drops of creosote being first sprinkled on the bottom of the box, and a few more drops on the lid when it has been filled. Ants are often a serious pest to the entomologist in the tropics. They will not enter boxes which have been prepared as above, but it is advisible to isolate the tables on which insects are kept by placing the legs in saucers or shallow tins, which are then thickly sprinkled with Keating's Powder or filled with kerosene. In no circumstances should water be used as this almost invariably serves as a place for mosquitos to deposit their eggs. Creosote must never be allowed to touch the specimens directly, and in all cases *it must be used very sparingly*, otherwise it is liable to discolour the insects permanently.

Bionomics.—Any information with regard to the natural habits of noxious insects is certain to be of value, however trivial it may appear to the observer. For example, any of the following points may be usefully noted; peculiarities of local distribution, seasons of appearance and disappearance, relative abundance in different years, times of feeding, nature of food, methods and times of egg-laying, food and habits of larvae, &c., &c. Further, good series of any injurious insect should be sent from every locality visited, even though they may be only a few miles apart: for only thus can a proper survey of its entire range be made. A knowledge of the egg, larva, and pupa is often of considerable importance, and whenever insects are being reared specimens of each stage should be preserved in spirit.

In the case of insects preserved in spirit it is desirable to keep them for a day or two in a weak solution of 35 or 40 per cent. before transferring them to the final solution of 65 or 70 per cent.

Where alcohol of known strength cannot be obtained, any spirituous liquid may be used provided it possesses the requisite strength. Any spirit which takes fire immediately on the application of a light, without having been previously warmed, is strong enough to be used for the preservation of animals.

Insects intended for anatomical examination must be fixed by heat, as their chitinous envelope is penetrated so slowly by alcohol that, if this be not done, they decompose before the preservative can reach them. It is sufficient to bring them to boiling temperature in a test tube of water: but for delicate histological

work it is better to boil in a mixture of equal parts of 90 per cent. alcohol (ordinary rectified spirit) and an aqueous solution (1 in 500) of perchloride of mercury. Even protozoal parasites are well preserved by this method. When fixed, preserve in 90 per cent. alcohol. *Methylated* spirit should *not* be used, as its acidity and other impurities may lead to embarrassment in the use of aniline stains.

The corks of tubes containing alcohol should be covered with paraffin wax to prevent leakage. In hot climates the wax of a stearine candle will be found more satisfactory on account of its higher melting point.

Collectors who desire to assist the Committee in furthering the organised study of African economic entomology should send their material to—

The Scientific Secretary,
Entomological Research Committee,
British Museum (Natural History),
Cromwell Road, London, S.W.

II.—INSTRUCTIONS FOR COLLECTING AND PRESERVING FLEAS.

Collecting.—Fleas are found on both birds and mammals, but in order to secure them the hosts must be examined when alive or just freshly killed: for fleas leave their host as soon as it gets cold.

Should the host be small, immediately after death it may be placed in a cyanide bottle, or in a small box or tin containing a few drops of chloroform, benzine, or ammonia. The fleas, after a few minutes, will be found dead at the bottom of the receptacle or among the hairs and feathers. They can then be easily picked up with a small moistened paint-brush and transferred at once to the alcohol in the collecting tubes.

In the case of large mammals and birds the fleas must be searched for by turning back the hair or feathers; and they may be killed by touching them with a brush moistened with spirit, benzine, or chloroform.

The following is a convenient plan for securing fleas found on birds:—Take a bird's nest immediately the young have left it and place it in a box, preferably one lined with white paper and with a glass top. A certain number of fleas will probably emerge at once from it; but there will be many larvae and pupae still in the nest. These may be reared simply by slightly moistening the nest from time to time, and mature fleas will frequently keep on emerging for six or eight weeks after the nest has been taken. The live fleas can be taken off the sides and top of the box with a camel's hair brush dipped in chloroform or benzine.

If it is impracticable to breed the fleas in this manner, the nest may be shaken up in a linen or paper bag containing several drops of chloroform or ammonia. After a few minutes the contents should be spread out on a white cloth or paper, and the dead insects can be picked up with a moist brush. Nests of moles, rodents, &c., can be treated in the same way.

It is important that the name of the host should be accurately determined, and therefore, wherever possible, skins of the smaller animals should be sent home for identification. Such skins would be returned, if desired. In the case of small mammals, the skulls should always be sent with the skins.

"Jiggers" or "chigoes" are highly specialised fleas, the females of which burrow beneath the skin of their hosts, on the more naked portions. They are to be found on many kinds of mammals and birds: and sometimes they present the appearance of small warts on the skin. For collecting purposes, they should not be pulled out, but, wherever practicable, the infected portion of the skin should be cut out and preserved in spirit; or the insects may be killed *in situ* with chloroform and then removed very gently.

Preserving.—Fleas should always be preserved in alcohol: 50 per cent. rectified spirit is found to be the most satisfactory strength. Each tube should contain the fleas from one host only, and many specimens should be sent, as frequently there are several species of flea on one animal.

Labelling.—In every tube a label should be inserted giving the locality, altitude, date, collector's name and name of the host: where the name of the host is unknown, a number should be given corresponding with one attached to the skin. Labels should be written very clearly in soft pencil or Indian ink.

Packing.—When packing tubes for transmission to England, a piece of soft crumpled paper should be inserted in each, in order to prevent the contents shaking about in transit. Care should also be taken to fill all tubes completely with alcohol before they are despatched, so as to leave as small an air bubble as possible. Reject all corks that appear defective and see that each cork is well rammed home and sealed with wax from a stearine candle. Then place the tubes in the receptacles provided for them, and carefully pack these in a covering box or tin.

III.—INSTRUCTIONS FOR COLLECTING TICKS.

Habitats.—All the domesticated and a large number of wild mammals are subject to the attacks of these pests. Some species also are to be found on birds (the head being the favourite point of attack), while others are peculiar to reptiles and batrachians. Several kinds attack man, especially in the larval stages; but the most important human ticks belong to the genus *Ornithodoros* (family *Argasidae*). These are not permanent parasites, and must be looked for in native huts, rest-places, &c.: they bite only at night, and during the day hide themselves in the dust on the ground, in the mud-cracks on the floor and walls, and also in the thatch. Fowls are subject to the attacks of a similar tick (*Argas persicus*), which may be found under similar conditions in fowl-houses.

Collecting.—Ticks vary greatly in size, not only in the different species, but also in the various stages of development. Examples of all sizes found on a host should therefore be collected and *a liberal supply of each should be sent*. The males of many species are relatively very small compared with the females, and require to be carefully searched for; they may often be found beneath the gorged females. Males of *Ixodidae* may be recognised by having the whole back covered with a hard shield.

If ticks are roughly removed, an important part—the "false head"—will be left behind, embedded in the host's skin, and the specimen spoiled. They may best be removed with a flat-nosed forceps, care being taken to grip the "false head" as close to the skin of the host as possible. If the creatures will not come away without breaking, they may be induced to let go by touching them with a brush or finger dipped in any oil. *Headless examples are useless for study.* The minute larvae ("seed ticks") may be removed with the blade of a knife and are best scraped direct into the tube.

All parasites from one species of animal from one locality and taken on the same day may be placed together in the same tube, but care must be taken not to mix the parasites of different animals (*e.g.*, sheep and cattle) though from the same place. Especially is it important to keep parasites from different localities separate.

Killing.—To kill ticks it is necessary only to drop them direct into the preservative. If the species are very active, they may be touched with a camel's hair brush moistened with chloroform or ammonia. When conditions are favourable, a good way to kill ticks is to drop them into 25 per cent. alcohol, to which 2 or 3 drops of ether have been added. The ticks then die with their limbs *extended*, and can afterwards be transferred to the proper preservative.

Preservatives.—It is preferable that ticks should always be preserved in liquids. Either of the following may be used: (*a*) 65 per cent. rectified spirit; if this is not procurable, undiluted whisky or gin may be substituted, though much less satisfactory; (*b*) 3 per cent. solution of formalin; care must be taken that the solution is not made stronger, as it would then render the specimens too hard and brittle. When plenty of material is available, both methods of preservation should be used.

Labelling.—Write *legibly* on a slip of good white paper: (1) name of host, or a number corresponding with one on the skin of host, if the latter is sent home for determination; (2) locality in full, not omitting the Colony or Protectorate, and in the case of farms or native villages, giving the approximate distance from the nearest well-known township, mountain, river, &c.; (3) altitude; (4) full date; (5) name of collector. Writing is best done with a fairly soft *black* graphite *pencil*. The label thus prepared should be placed *inside* the tube with the specimens. If ordinary writing ink is used the label must be attached to the outside of the tube. When it is desired to send fuller notes concerning certain species, take a piece of soft tissue paper, write a number on it in pencil, then fold up several specimens of one species in it: the paper should be folded over a good many times, and its final size should be such that it fits tightly into the tube and cannot become unfolded in transit. Under a similar number an account can be sent home of the habits, &c., of the species. In the case of distinctively coloured species, the colours should be noted during life and duly recorded. Any notes on habits, distribution, frequency, &c., would be greatly appreciated.

Packing.—See that the corks of the tubes are well rammed home. Reject all defective corks. When the tubes are being finally closed, a lightly crumpled piece of soft paper may be inserted to prevent the specimens moving about too much. The tubes should also be quite filled up with the preservative. A large

air-bubble may be avoided by pressing the cork to one side when pushing it home. When the tube has been closed, the cork and the edges of the tube should be covered with melted wax to check leakage: the wax from an ordinary *stearine* (or mining) candle will be found most satisfactory. The tubes must be returned in the wooden cases provided, and these should be carefully packed in a covering box or tin.

IV.—INSTRUCTIONS FOR COLLECTING AND PRESERVING BED-BUGS (*CIMICIDAE*).

Collecting.—When a house in the tropics is found to contain bugs, the tops of all the mosquito-nets should at once be examined, as that is a favourite resort for these insects. Bugs may also be obtained, when troublesome, by spreading a broad ring of pyrethrum powder right round the lower sheet or blanket upon which the sleeper lies: every bug that crosses this to attack him will be found more or less disabled in the morning.

Where fowls are kept, the nesting-boxes should be periodically examined, for these will often be found simply teeming with bugs: and this should always be suspected when the fowls are found to be laying away from their boxes. Bugs are also to be found in some birds' nests, especially those of swallows. Other species specially attack bats; these are mostly to be found in the cracks and crannies about the places where bats roost, and can be driven out by the use of ammonia or tobacco smoke: sometimes the insects are found attached to the membrane of the bat's wings, which should always be carefully examined.

It is quite probable that on fuller investigation different species of bugs will be found frequenting the lairs of many other animals.

Killing.—These insects may either be killed in the cyanide bottle or dropped directly into the preserving fluid.

Preserving.—Bed-bugs should *never* be preserved dry: they should be kept in 60 per cent. spirit or 3 per cent. formalin. As far as possible, each tube should contain the bugs from only a single host.

Labelling and Packing.—*See* the instructions given for ticks.

V.—DIPTERA (TWO-WINGED FLIES). INSTRUCTIONS FOR COLLECTING MOSQUITOS, AND OTHER SMALL OR DELICATE FLIES.

Collecting.—Many species of mosquitos may be obtained during the day in shady woods or forests: others prefer open, swampy ground, and can best be secured in numbers just after sunset: others again can be most conveniently collected in houses. When caught with a net in the open the insects should be brought home alive in glass-bottomed pill-boxes. In houses, it will be found that most of the mosquitos fly to the windows at dusk, and they may then be caught in the following way: Take a pill-box and firmly fix across the bottom a strip of blotting-paper, on which place a drop or two of chloroform or ammonia: the box should then be put over a mosquito on the window; in a few seconds the insect will be partly stupefied and can then be transferred at once to the cyanide bottle, the box being immediately placed over another insect, and so on; by this means a good series can often be obtained with

comparatively little trouble. These insects often collect in some numbers during the day on the thatch inside native huts, and many may be captured with a few sweeps of the net; special attention should also be given to those species which attack domesticated animals. Mosquitos may be bred quite easily from larvae, and this method of collecting should be adopted whenever practicable.

The minute insects known as "sand flies" (*Simulium*, *Phlebotomus* and *Culicoides*) should be carefully collected. *Simulium*, so far as is at present known, breeds in shallow running streams. The larvae attach themselves to the stems of plants and stones; when matured, the flies are readily bred by placing the larvae *in situ* on portions of the plant or on stones in a glass vessel, which should be covered over with a piece of rubber sheeting. Water must not be added or the larvae will die off rapidly. The plants or stones, however, must be kept moist. *Phlebotomus* may be looked for in latrines and damp shady places. *Culicoides* often swarm along rivers and elsewhere: the members of this genus are all minute, and examples should be preserved in alcohol as well as in a dry condition.

Killing.—When the mosquitos, &c., have been brought home alive, they may be killed by the method described under the heading "Brass chloroform-bottle." Ammonia may be used instead of chloroform, but on no account should they be shaken into the killing bottle as they are thus inevitably damaged. The boxes should be afterwards left open some time before being used again for live insects.

Preserving.—For all general purposes it is desirable that mosquitos should be preserved *dry*. Specimens to be identified must *on no account* be placed in spirit. Mosquitos must be dealt with *as soon as possible after death*, for they very rapidly become dry and stiff, in which state they cannot be touched without breaking and are therefore useless for transmission.

The insects may be sent home either pinned or unpinned. If *pinned*, the following process should be adopted. Cut a small piece of paper of sufficient size to write on it all data connected with the specimen to be pinned, as follows: name of *locality*, including *altitude* if necessary; *date*—day, month, year—thus, 9. XI. 98; *collector's name*; any *remarks of interest*, *e.g.*, "Most troublesome species in district," "Abundant only in open swamps," "Uncommon," &c. Then take one of the fine No. 20 pins and thrust it through the middle of the mosquito's thorax on the *upper* side, gently pushing the insect two-thirds of the way up the pin and taking great care not to break off the legs; this may conveniently be effected by stretching a corner of a handkerchief between the fingers and then gently pushing the pin through the fabric.

In the case of mosquitos, a good number of specimens of each species (but not more than half) should be pinned through the side of the thorax instead of from above; while the majority (say two-thirds) of the midges and sand flies should be pinned in this manner. Then place the paper on a piece of cork or peat with the writing downwards, seize the pin with the forceps (*below* the specimen) and thrust it through the paper, and finally, with a pin, arrange the wings so that they project at an angle from the body and dispose the legs symmetrically. This latter operation must be performed very gently, and care must be taken

that hairs and scales are not rubbed off; as the tissues contract in drying, the legs and wings are very apt to get pulled out of place, and to correct this, the specimens should be examined once or twice during the next day or two. If precisely the same data apply to a number of specimens, it will be necessary to label only two or three, provided that a small label bearing the same number be attached to every specimen; or else this may be indicated by drawing a pencil line round the whole group on the bottom of the box in which they are ultimately pinned.

Packing.—*Pinned specimens.*—The inside of the box into which the insects are to be pinned should first be rubbed with a piece of sponge, or swab of cotton-wool, soaked in a saturated solution of naphthalin in chloroform, mixed with an equal quantity of medical (beechwood) creosote: the mixture being applied until the cork-lining shows through the paper. This process will prevent mould and keep out destructive insects. The specimens should then be very firmly pinned into the box, a sheet of newspaper or other soft paper should be placed over the side containing the insects with the edges projecting so that on closing the lid it is held firmly in position. This minimises the risk of injury in the event of any of the specimens becoming loose in transit. The box containing the pinned insects should then be *well wrapped* in cotton-wool, shavings or moss, and enclosed in a covering wooden or tin box.

Unpinned specimens.—These should be packed in the following manner, immediately after being killed. Take a very small piece of cotton-wool, tease it out into a light web-like mass, put this into a pill-box and so arrange it that it fills about two-thirds of the receptacle. Place the mosquitos or other small flies upon the wool, care being taken to distribute them evenly, and not too closely, over its surface. A very thin web-like layer may then be placed over the insects, but there must be *no pressure* upon them, *tight packing must be strictly avoided*, and unravelled plugs of wool must not be used. *Dry rigid specimens cannot be packed in this way.* There must be only one layer of insects in each box. A single drop of medical creosote should be placed on the inside of the lid of the pill-box; if too much creosote be used, the specimens will be permanently discoloured. The data should be written, as above, on the outside of the box. The pill-boxes may then be carefully packed in a strong larger box for transmission. When sufficient specimens are available, it is advisable that both methods of packing should be used, and in the case of biting flies, some of each kind should also be preserved in spirit.

Va.—INSTRUCTIONS FOR COLLECTING LARGER DIPTERA (TWO-WINGED FLIES).

Collecting.—In general, flies should be brought home alive in the glass-bottomed pill-boxes: but when large numbers are being caught this is sometimes impracticable, and a cyanide-bottle containing pieces of soft crumpled paper should be carried in the field. It is worth noting that Diptera may often be captured in quantities by sweeping in open marshy ground or in damp shady places. When a good many have thus been secured in the net, it should be waved rapidly backwards and forwards with one hand, then with the other hand the

bag of the net should be seized near the bottom so as to imprison the flies in a small space; this portion can then be placed bodily into the killing-bottle for a minute or so, and when the insects cease to move they can all be transferred to the bottle.

The flies which are most urgently required are those which suck the blood of men and animals, and of these long series should be sent from every different locality visited. *Tabanidae*, *Stomoxys*, and tsetse-flies (*Glossina*) may often be captured while attacking man and other mammals: and it should be remembered that freshly-killed animals are often as attractive, if not more so, than living ones.

Killing.—Flies brought home alive may be killed by the method recommended for mosquitos.

Preserving.—For general purposes these insects should be preserved *dry*, either pinned or in papers.

Pinned Specimens.—For insects not larger than a blue-bottle a No. 10 pin should be used, and they should be treated in exactly the same manner as mosquitos. In the case of larger flies, they may be pinned with the long No. 16 pins. The insect should be pushed up the pin for at least two-thirds of its length, and a card, on which all the data have been written, should be run up the pin close beneath the insect, so as to serve as a support for its legs.

Unpinned Specimens.—Prepare a number of rectangular pieces of fairly thin *soft* paper; $2 \times 2\frac{1}{2}$ inches will be the most generally useful size, but $2\frac{1}{4} \times 3$ inches would be needed for the largest Diptera. Take one of these papers and write on it all the particulars of capture, including the locality, date, name of collector, &c. Make this into a "cushion" envelope as described and figured on page 229, and pack *only one* insect in each. *Never use gum to fasten the edge of the envelopes.*

Packing.—*Pinned Insects.*—These should be treated in precisely the same manner as mosquitos. In the case of large insects, special care must be taken that the pins are firmly driven into the bottom of the box as far as they will go. In doing this never hold the pin above the insect, but always *below* it.

Insects in Papers.—For packing these, take a small tin or wooden box, pour a few drops of medical creosote and also a spoonful of *melted* naphthaline into it to prevent mould. Cover the bottom with a sheet of paper, then carefully put in the envelopes in such a way as to *minimise the pressure* on the insects, and replace the lid as soon as possible to prevent the evaporation of the creosote. When the box is full, place a layer of teased-out cotton-wool on the top of the envelopes, using just sufficient to prevent them from moving about *without unduly pressing* the specimens. Carefully pack the box in a covering box, and dispatch it as soon after it is filled as possible. If the specimens have been kept for six weeks or so before posting, put a *few* more drops of creosote on the cotton-wool covering the envelopes. On no account must an excess of creosote be used or it will discolour the insects. If medical creosote or other preventive of mould is not procurable, the insects must be kept in *wooden* boxes only and as free from damp as possible. In very moist climates it may be found necessary to expose such specimens near a fire from time to time, or to place them in the sun, care being taken not to allow ants or other destructive insects to gain access to them.

VI.—TSETSE-FLIES.

Some of the Points on which Observations are wanted.

1. *Locality.*—Name of colony and nearest station, river, lake, &c. It is not always possible in England to identify native villages.
2. *Where caught.*—On road, at ford, in village, close to village, far from human habitation, on railway, &c.
3. *Altitude*, if known.
4. *Time of day.*—If caught at night, ? moonlight.
5. *Nature of country.*—River bank, grassy plain, dense forest, thorny scrub, &c.
6. Presence or absence of *water.*
7. *Dry or wet season.*—State whether the grass or scrub is burned in the dry season.
8. Presence of *more than one species.*—This is easily overlooked, as some of the species are very similar to one another.
9. *Numbers of fly.*—Half-a-dozen, numerous, very numerous, swarms, &c.
10. *Ratio of the sexes.*—Males usually outnumber females.
11. Do the flies bite through clothes?
12. Have you observed any bird or insect preying on the flies?
13. Do the flies go to the water to drink?
14. Are cattle, sheep, goats, or horses kept in the fly region?
15. Presence or absence of sleeping sickness.

Observations carried on month after month at one spot are of more value than spasmodic research in diverse districts.

VII.—INSTRUCTIONS FOR COLLECTING LICE.

I.—*Sucking Lice* (Anoplura).

The true or sucking lice are placed by most systematists near the Rhynchota (Hemiptera) and the Thysanoptera. Their mouth organs partly consist of very thin, long, piercing-bristles. These are, however, very difficult to see on account of their extreme thinness and lack of all colour. By means of these organs the Anoplura can be distinguished from the so-called biting lice, Mallophaga, which live on the hair or feathers of their hosts and whose mouth parts are adapted to biting as opposed to sucking.

The Anoplura can be found on all mammals of all sizes. In most cases they can be combed out from the hair of their hosts with a common tooth-comb. In the case of mammals with very slight pelage it is better to search the skin for these parasites, which can be killed by dropping a few drops of chloroform on them, and can then be removed with a small brush or a pair of forceps. As a rule, only a few individuals of any one species of mammal are infested with lice, but in these cases the insects generally occur in large numbers and especially so if the animal is young or weak. It is very advisable to examine a large number of individuals of any one host, especially of those from which no lice are as yet recorded. Lice are especially desired from all carnivora, such as cats, carnivorous whales, &c. Aquatic animals such as seals, are often

infested with lice in the neighbourhood of the nose and mouth, even when there are none to be found on other parts of the body. Large quantities of each species should be collected, and also larvæ in all their stages. The eggs are also of very great importance. They are always laid on the hairs, and the hairs should be cut off with the eggs adhering to them. The parasites from each individual host should always be kept separate from any others, whether these are collected on the same species of animal or a different one, and it should be noted that as the parasites leave their host as soon as it gets cold, there should be no loss of time in examining the dead animal. Lice can frequently be collected from mammals in captivity in zoological gardens, especially when they are freshly captured. For preserving lice the following method is recommended. The parasites and their eggs and larvæ have simply to be placed in a small glass tube filled with alcohol. A label should then be inserted giving the name of the host, the date, and locality. When recording data the following points are essential :—(1) Exact locality and its altitude ; (2) date : (3) the name of the host, and if this is unknown, a number corresponding to numbered specimens of the host ; (4) the age and sex of the host : (5) condition of the host, *i.e.*, whether weak or emaciated, or in good condition : (6) position on the body of the host where lice were chiefly found and also position of the eggs : (7) collector's name.

II.—*Biting Lice* (Mallophaga).

The biting lice or Mallophaga, which live on hair and feathers, are in no way related to the previously mentioned Anoplura, but are Neuroptera allied to the Copeognatha (*Psocidæ*). They undoubtedly bear a striking superficial resemblance to the Anoplura, especially as they possess tarsi with strongly developed claws, and the thorax and abdomen are strongly compressed dorso-ventrally, but notwithstanding all these characters they are in no way related.

The biting lice living on mammals (sometimes called hair lice) occur, like the sucking lice, on all mammals, and the eggs of these parasites, which are very important and have a characteristic shape for each species, should be carefully collected. The feather lice or biting lice found on birds cannot be combed out from their hosts, which is the method suggested for the previously-mentioned insects. These must be taken off from the host with a brush previously moistened with chloroform or benzine. On one species of bird quite a number of lice of different genera and species can often be found. The eggs of feather lice are generally laid on the under surface of the feathers and frequently on the base of the feather, and as they are usually deposited in little groups they can easily be cut off and preserved. Collectors should note that some species of Mallophaga, like the Anoplura, often leave their host as soon as it gets cold. The method of preservation for Mallophaga is the same as that recommended for the Anoplura.

GAMBIA

BULL. ENTOM. RESEARCH, VOL. II., PART 3.

MAP TO ACCOMPANY REPORT BY JAS. J. SIMPSON,
SHOWING THE
DISTRIBUTION OF GLOSSINA AND SLEEPING SICKNESS
IN THE GAMBIA.
Route followed by the Author
Localities where Glossina palpalis was found
" " " morsitans "
Villages in which Sleeping Sickness "
NIUMBATO
Dense Forest
Bathurst
Barra Point
Cape St Mary
Bintang Bolong
Jeshwang
Bakau
Fajara
Hagan
Serekunda
Brefet
Bald Cape
Sukuta
Tanji
Brikama
Mansakonko
Kuntaur
Jarra
Berending
Kwinella
Kaur
Sabach Sanjal
Kau-ur
Pisanfarra
Kerewan
Albreda
Georgetown
Yundum
Bansang
Basse
Kantora
Hambo and Small Trees
Kumbo Tree
Kuntaya
Kaiaf
Kau

THE AFRICAN SPECIES OF CULEX AND ALLIED GENERA.

By F. W. Edwards, B.A.

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The writer's original intention in publishing this paper was to give a key for the identification of those African mosquitos which might be taken by the non-specialist for species of *Culex*, without attempting to form any opinions as to the value or limits of allied genera. A study of the insects, however, led to the realisation that scale characters, in this group at least, are not of very great value for separating genera, and consequently the present paper gives the author's views of the classification of the *Culex* group, and is more complete than it might otherwise have been. Time has not yet been available to deal with those species which have flat scales on the top of the head or on the scutellum (*Stegomyia* group).

It will be noticed at once that a large number of names (nearly seventy) have been sunk as synonyms, and it may be as well to point out that this has, as a rule, only been done after a careful comparison of the types. Where there is room for doubt as to the synonymy of two names, this has been freely admitted.

All that is claimed for this paper is that it may make the determination of good specimens a little easier than up to the present. The group of species including *Culex invidiosus*, and some other species, are very difficult to classify, and the author has not been able, much to his regret, to find any clearly marked distinctions.

The Culicidae as a whole are classified as follows by Lt.-Col. Alcock (Ann. Mag. Nat. Hist. (8) viii., p. 241, 1911) :—

Sub-family A. **Corethrinae.** (Proboscis short.)

Sub-family B. **Culicinae.** (Proboscis long.)

Section 1. Megalorhini. (Proboscis very long and bent downwards. Usually large metallic species.)

Section 2. Epialurgi = Anophelinae of Theobald. (Palpi long in ♀.)

Section 3. Culicales, comprising Culicinae, Heptaphlebomyinae, Dinoceratinae, Aedinae and Uranotaeniinae of Theobald. (Metanotum bare.)

Section 4. Metanototricha, comprising Trichoprosoponinae, Dendromyinae and Limatinae of Theobald. (Metanotum bearing bristles.)*

This grouping of the main divisions of the family is in the present writer's opinion the best that has yet been proposed. Many recent authors have adopted an essentially similar plan, but have made only three divisions of the Culicinae (or, where the Corethrinae are regarded as a separate family, three sub-families of Culicidae), the Megalorhini (Megarhininae of Theobald) being included with the Culicales. It seems better, however, owing to the many differences of structure between the two groups, to keep them separate.

* [It has very reasonably been suggested to me that it is advisable to use similar terminations for the names given to groups of equal value ; and further, that it is inadvisable to interfere with the established name of "Anopheline" for the malaria-carrying mosquitos. Mr. Guy Marshall proposes the names (1) *Megalorhinina*, (2) *Anophelina*, (3) *Culicina*, and (4) *Metanototrichina*, for the four sections of Culicinae, and with this proposal I entirely concur.—A. Alcock.]

The Culicales may be divided further into two main groups as follows :—

Sub-section I. Culicides. Palpi of ♂ longer than those of ♀.

Sub-section II. Aedides. Palpi similar in both sexes.

Further sub-division, except into genera, is unnecessary, and probably not advisable.

In the following table are included all those forms of the Culicides (Theobald's sub-families *Culicinae* and *Heptaphlebomyinae*) which have no flat scales on the scutellum or on the middle part of the head. The genus *Ludlowia* has also been included owing to the similarity of the females to *Culex*, and the fact that not all the species have a flat-scaled head.

Table of Genera.

1. Male palpi much shorter than proboscis ... ... 2.
   „ never much shorter than proboscis (in *Theobaldia spathipalpis* they often shrink and curl up, so as to *appear* shorter than the proboscis) ... ... 3.
2. Ungues all simple in both sexes ... Protomelanoconion, p. 244.
   Fore and mid ungues dentate in both sexes ... [two undescribed species].
3. Male palpi apparently 2-jointed ... ... 4.
   „ „ 3-jointed ... ... 5.
4. Fore and mid ungues of female simple ; first fork-cell in female shorter than second ; wings nearly bare on lower half Ludlowia, p. 244.
   Fore and mid ungues of female dentate ; first fork-cell in female longer than second : thorax deep yellow at sides Banksinella, p. 245.
5. Last two joints of male palpi thickened, terminal usually shorter than penultimate and turned slightly downwards (fig. 1) ... ... 6.
   Last two joints of male palpi thin, mucronate and curved upwards 9.
6. Fore and mid ungues of male and female dentate (both claws) ... 7.
   All ungues of female, and hind pair of male, simple ... ... 8.
7. Female palpi more than half as long as proboscis ; wing-scales broad, legs densely clothed with outstanding scales Mucidus, p. 246.
   Female palpi less than half as long as proboscis ; wing-scales mostly narrow : legs without outstanding scales Ochlerotatus, p. 246.
8. Smaller claw on fore and mid tarsi of male toothed ; large species Theobaldia, p. 251
   Smaller claw on fore and mid tarsi of male not toothed ; medium-sized, usually yellow species ... Taeniorhynchus, p. 251.
9. Terminal joint of male palpi very short (fig. 2) ; wing-scales all broad ... ... Mansonioides, p. 253.
   Terminal joint of male palpi nearly as long as or longer than penultimate ; wing-scales mostly narrow ... . 10.
10. Male palpi with a row of outstanding transparent whitish scales ; a row of flat opalescent scales round the eye-margins in both sexes Culiciomyia, p. 254.
    Male palpi without such scales (fig. 3) ; flat scales not continuous round eye-margins ... ... Culex, p. 256.

Table of Females.

(Species of the *Aedes* group (not included in this table), though obscure-looking, nearly always have a flat-scaled head).

1. Fore and mid ungues toothed ... ... 2.
   All ungues simple ... ... 5.
2. Hind ungues toothed ... ... 3.
   „ „ simple ... ... 4.
3. Palpi more than half length of proboscis; wing scales broad; legs shaggy ... ... MUCIDUS, p. 246.
   Palpi less than half length of proboscis; wing scales narrow; legs not shaggy ... ... OCHLEROTATUS, p 246.
4. Thorax bright yellow at the sides ... ... BANKSINELLA, p. 245.
   „ not bright yellow at sides ... ... OCHLEROTATUS, p. 246.
5. Distinctly yellow species: legs largely yellow TAENIORHYNCHUS, p. 251.
   Not yellow species ... ... 6.
6. Wing-scales all very broad (compare also *Aedeomyia*) MANSONIOIDES, p. 253.
   „ mostly narrow ... ... 7.
7. Head mostly covered with flat scales (as in *Stegomyia*, etc.) LUDLOWIA, p. 244.
   „ „ „ „ narrow curved scales ... ... 8.
8. Head with a row of small flat scales round the eye-margins CULICIOMYIA, p. 254.
   Head without flat scales on the occiput ... ... 9.
9. Last two joints of hind tarsi white LUDLOWIA (MEGACULEX), p. 244.
   „ „ „ not white ... ... 10.
10. Large to medium-sized species: femora and tibiae with pale spots 11.
    Femora and tibiae not spotted ... ... 13.
11. Thorax with distinct narrow white lines; a pale ring before tips of femora ... ... *Theo. spathipalpis*, p. 251.
    Thorax without white lines ... ... 12.
12. Thorax with the anterior two-thirds, or at least the middle third, with pale scales ... ... *C. quasigelidus*, p. 258.
    Thorax not so marked; spots on legs more numerous *C. tigripes*, p. 261.
13. Thorax with the anterior two-thirds bearing pale scales ... ... 14.
    „ almost uniformly scaled ... ... 16.
14. Violet-blackish species ... ... *Taen. metallicus*, p. 252.
    Not violet-blackish species ... ... 15.
15. Abdominal segments with pale median basal spots *C. annulioris*, p. 259.
    „ without such spots ... ... *C. consimilis*, p. 259.
16. A well-defined margin of white scales to eyes; small grey species, with small whitish basal spots on abdominal segments *Prot. fuscum*, p. 244.
    No well-defined rim of white scales to eyes (except sometimes in *C. grahami*) ... ... 17.
17. Large species, joints of tarsi basally banded *Theo. annulata*, p. 251.
    Medium-sized or small species, tarsi not banded, or rarely with basal and apical bands ... ... CULEX, p. 256.

Genus Protomelanoconion, Theo.

Mon. Cul. V, p. 462 (1910).

1. **P. fuscum**, Theo., Mon. Cul. V, p. 463 (1910).

Although the generic characters will at once distinguish the male from all the related genera, the female is a very obscure insect, and might easily be mistaken for a small *Culex*, a *Culiciomyia*, or an *Aedes*. It perhaps bears the greatest resemblance to a *Culiciomyia*, since it has the same rim of white scales round the eye-margins: but an examination with the microscope shows that the white scales are narrow-curved and not flat. *P. fuscum* ♀ can be distinguished from *Culex grahami* and its allies by the much longer bristles on the thorax.

Genus Ludlowia, Theo.

Mon. Cul. IV, p. 193 (1907).

Megaculex, Theo., Mon. Cul. IV, p. 282 (1907).
Radioculex, Theo., Rec. Ind. Mus. II, p. 295 (1908).
Hispidimyia, Theo., Mon. Cul. V, p. 245 (1910).

The essential characters of the genus are:—(1) the apparently 2-jointed ♂ palpi, of which the apical joint is swollen; (2) the short fork-cells, especially the first; (3) the rather peculiar shape of the marginal cell; (4) the nearly bare posterior half of the wings; (5) the structure of the ungues, which is essentially the same as in *Culex*, but the larger claw on the anterior tarsi of the male always has two teeth; (6) the long antennae of the ♂, usually longer than the proboscis.

Ludlowia was founded on *Mimomyia* (?) *chamberlaini*, Ludlow, and *Radioculex* on *R. claripalpus*, Theo. An examination of the types, however, shows that these are in reality one and the same species. *Hispidimyia hispida*, Theo., is very little different from *L. chamberlaini*, and *Megaculex albitarsis*, Theo., has all the essential characters of the genus.*

Table of species of Ludlowia.

1. Head with mostly narrow-curved and upright-forked scales in middle; last two joints of hind tarsi white (subgenus *Megaculex*) 2.
   Head mostly covered with flat scales, except for a very small area behind; last two joints of hind tarsi not white (subgenus *Ludlowia* ... ... 3.
2. Large species, 7–8 mm. in length ... ... *plumosa*.
   Small species, 3 mm. in length ... ... *pincerna*.
3. Legs narrowly banded, last hind tarsal joint whitish (*chamberlaini*)†
   „ uniformly dark ... ... *hispida*.

* Since the above was in type I have had an opportunity of examining a male of *Boycia mimomyiaformis*, Newst. (*vide* p. 266), from Derri, N. Nigeria (*J. J. Simpson*). It evidently belongs to the subgenus *Megaculex* of *Ludlowia*.

† This species does not occur in Africa.

1. **L. plumosa**, Theo., (*Culex*) Mon. Cul. I, p. 373 (1901).

Megaculex albitarsis, Theo., Mon. Cul. II, p. 25 (1901).

The hind tarsi of the type of *L. plumosa* are missing, and as Theobold puts a query against his statement that the hind ungues are simple, I assume that they were absent when the insect was described. The only difference I can see between the types of *L. plumosa* and *M. albitarsis* is that in the former the upright forked scales of the head are dark, whereas in the latter they are yellow. There is variation in this respect, however, in the small series (four specimens) of *M. albitarsis*. Theobald incorrectly describes and figures the fore and mid ungues of the ♂ *M. albitarsis* as unidentate: the two teeth on the larger claw are quite evident in the type.

S. Nigeria; Congo Free State; Uganda; Mashonaland.

2. **L. pincerna**, Graham, (*Megaculex*) Ann. Mag. Nat. Hist. (8) V, 1910, p. 267.

Graham makes the same mistake as Theobald in describing the ♂ ungues. The basal tooth on the larger claw is much more difficult to see than the median one, and is probably overlooked in very many cases. As, however, its presence or absence is not usually a generic character, the oversight (which is very excusable) is not of serious import.

S. Nigeria.

3. **L. hispida**, (*Hispidimyia*) Theo., Mon. Cul. V, p. 245 (1910).

Specimens have been received at the Museum from Kampala Swamp and Kibanga, Uganda (*Capt. A. D. Fraser*).

Sudan; Uganda.

Genus Banksinella, Theo.

Mon. Cul. IV, p. 468 (1907).

1. Costa spotted with black and yellow; hind femora yellow with black apical ring ... ... *punctocostalis*.
„ uniformly dark; hind femora all dark above ... ... 2.
2. Proboscis unbanded ... ... *luteolateralis*.
„ banded ... ... *taeniarostris*.

1. **B. punctocostalis**, Theo., Mon. Cul. V, p. 407 (1910).

Ashanti.

2. **B. luteolateralis**, Theo., Mon. Cul. II, p. 71 (1901).

Taeniorhynchus lineatopennis, Ludlow, Canad. Ent. XXXVII, p. 133 (1905).

Banksinella chrysothorax, Theo., (♂) Mon. Cul. V, p. 404 (1910).

Generally distributed over Africa: Philippine Is.: Perak, Malay States.

3. **B. taeniarostris**, Theo., Mon. Cul. II, p. 405 (1910).

The hind ungues of this species and of *B. punctocostalis* are simple, as in *B. luteolateralis*, of which this is perhaps a well-marked variety.

Ashanti.

Genus MUCIDUS, Theo.

Mon. Cul. I, p. 268 (1901).

1. **M. scatophagoides**, Theo., Mon. Cul. I, p. 277 (1901).

M. sudanensis, Theo., Third Rep. Wellc. Lab. p. 252 (1908).

Tibiae with pale bands at the base, middle and apex, all of about equal breadth. All tarsi with pale basal bands, most marked on the hind pair. Wing-fringe with eight pale spots.

The proboscis of *M. sudanensis* is said by Theobald to have a white band at the tip; this is an error, and the statement was evidently intended to apply to the *palpi*, the last joint of which is white. The species is closely related to the Australian *M. alternans*, Westw., which differs in having the tibiae dark at the apex, with two narrow white bands.

Sudan; Gold Coast; India.

2. **M. mucidus**, Karsch, Ent. Nachr. 1887, p. 25.

M. africanus, Theo., Mon. Cul. I, p. 274 (1901).

M. grahami, Theo., Mon. Cul. V, p. 127 (1910).

Fore and mid tibiae narrowly white at base, broadly white at apex. Hind tibiae narrowly white at base and apex and with a very narrow indistinct white band in the middle. Fore and mid tarsi all yellowish. Wing-fringe usually with seven pale spots.

The type of *M. grahami* is a dark specimen, in which the pale fringe spots are indistinct, only four being clearly visible, and traces of two others. Apart from this it does not differ from *M. mucidus*. The type of *M. africanus* has seven pale fringe-spots, not five as stated by Theobald.

M. alternans does not occur in Africa; the Natal specimen included by Walker in his series of *Culex commovens* (=*M. alternans*) is apparently a variety of *M. mucidus*.

Sierra Leone; Ashanti; S. Nigeria; N. Nigeria; Nyasaland Protectorate; Delagoa Bay.

Genus OCHLEROTATUS, Arrib.

Rev. Mus. La Plata, II, p. 143 (1891).

Culicada, Felt, N.Y. State Mus. Bull. No. 79, p. 391 b (1904).

Culicelsa, Felt, *l.c.*

Mimeteculex, Theo., Third Rep. Wellc. Lab. p. 258 (1908).

Grabhamia, Theo., part.

Coquillett (Science, vol. 23, p. 314, 1906) sinks both *Culicada* and *Culicelsa* under *Ochlerotatus*, and though Theobald (Mon. Cul. IV, p. 14) regards this as a retrograde step, it seems to be inevitable. The present writer is in entire agreement with Coquillett as to the taxonomic value of toothed or simple claws in the female, as all other characters seem to support divisions based on this. A more detailed study may reveal satisfactory characters by which to separate *Culicelsa* and *Ochlerotatus* (*Culicada*), but at present such have not been discovered. Dyar, using the male genitalia as a basis of classification, doubts whether the two genera can be kept separate. The chief structural difference appears to be that in *Culicelsa* the hind ungues are simple, while in *Culicada* they are toothed; but *O. caliginosus* and *O. ochraceus* have the hind ungues simple in the male, but toothed in the female, so that this character cannot be of very great importance.

The genus *Ochlerotatus* is certainly well founded, and is accepted here in its original sense, with the slight modification necessary for the inclusion of *Culicelsa*. *O. albifasciatus*, Meq., the type of the genus, is unrepresented in the British Museum Collection, two specimens so named by Walker certainly being wrongly identified. *O.* (*Leucomyia*) *scapularis*, Rond., is of precisely the same type as the species tabulated below, and is certainly not congeneric with the other species of *Leucomyia*, which are here included in *Culex*.

Theobald in publishing *Grabhamia* did not cite a type in any way, and Dyar (Proc. Ent. Soc. Washington, 1905, p. 48) specified *Culex dorsalis*, Mg., as the type; Felt, however, had previously (*loc. cit.*) chosen *C. jamaicensis*, Theo., which appears to be a true *Culex*. The genus *Grabhamia*, therefore, is not synonymous with *Ochlerotatus* and *Culicada*, but with *Culex*.

Ochlerotatus is mainly a Palaearctic genus, comparatively few species occurring within the tropics, where, on the other hand, *Culex* is more largely developed. The *Culicelsa* group includes (besides *C. taeniorhynchus*, Wied., the type, and the African species given below), *Culex vigilax*, Skuse, *Taeniorhynchus niger*, Giles (which is very close indeed to *C. taeniorhynchus*, Wied.) and others. *C. alboannulatus*, Meq., is a true *Ochlerotatus*. *C. accraensis*, Theo. (*neotaeniorhynchus*, Theo.) is a *Culex*. In addition to the differences in ungues and male palpi, *Ochlerotatus* seems to differ from *Culex* in the structure of the male antennae, the plumes arising from the dorsal and ventral surfaces of the antenna only, instead of in whorls as in *C. pipiens*. Whether the two genera can always be distinguished in this way I am unable to say, as time has not allowed the examination of the antennae of very many species.

1. Hind ungues toothed in both sexes (*Ochlerotatus*, s. str.) ... ... 2.
   „ „ simple in ♂ ... ... 6.
2. Tarsi unbanded... ... ... 3.
   Tarsal joints banded at both base and apex ... ... 5.
3. Abdomen unbanded, but in ♀ with very small median basal pale spots ... ... 1. *cumminsi*.
   Abdominal segments basally banded ... ... 4.
4. Thorax more or less ornamented with pale lines: wings without light scales ... ... 2. *dentatus*.
   Thorax uniformly scaled; wings with light and dark scales (N. Africa and Europe only) ... ... 3. *nemorosus*.
5. Banding of tarsi rather broad; abdominal segments with pairs of dark patches ... ... 4. *dorsalis*.
   Banding of tarsi narrow; abdomen almost all pale... 5. *longisquamosus*
6. Hind ungues simple in both sexes (*Culicelsa*) ... ... 7.
   „ „ toothed in female ... ... 12.
7. Legs banded ... ... 8.
   „ unbanded ... ... 11.
8. Tarsal joints with apical and basal banding ... ... 6. *pulcritarsis*.
   „ „ basal banding only ... ... 9.
9. Wings mottled with black and white scales; dark species ... 10.
   „ not mottled; more brownish species; costal fringe whitish beyond middle ... ... 7. *hirsutus*.
10. Abdominal segments with apical lateral yellowish spots 8. *durbanensis*.
    „ „ without such spots ... ... 9. *nigeriensis*.

11. Abdominal segments with complete basal bands ... 10. *quasiunivittatus*.
„ „ basal lateral white spots; thorax whitish at sides ... ... 11. *lateralis*.
12. Smaller blackish species; hind ungues in ♂ equal ... 12. *caliginosus*.
Larger yellowish species; hind ungues in ♂ unequal (*Mimeteculex*, Theo.)... ... ...13. *ochraceus*.
Species *incertae sedis*: a rather broad whitish band at apex of hind tibiae; scutellum with golden-yellow scales ... ... 14. *leucarthrius*.

1. **O. cumminsi**, Theo. (*Culex*), Mon. Cul. III, p. 214 (1903).
Culicada mediopunctata, Theo., Mon. Cul. V, p. 304 (1910).
„ *fuscopalpalis*, Theo., Mon. Cul. V, p. 307 (1910).

The type of *C. mediopunctata* is only a variety of *O. cumminsi* with unusually large abdominal spots, traces of which can almost always be seen. The male genitalia of *C. fuscopalpalis* do not differ from those of *O. cumminsi*.

Nyassaland Protectorate; Uganda; Ashanti.

2. **O. dentatus**, Theo. (*Culex*), First Rep. Wellc. Lab., p. 75 (1905).

Evidently closely allied to *O. cumminsi*, but differs in the banded abdomen. The male is at present unknown.

Abyssinia; Transvaal.

3. **O. nemorosus**, Mg., Syst. Beschr. I, p. 4 (1818).
(?) *Grabhamia maculosa*, Theo., Ann Mus. Nat. Hung. III, p. 105 (1905).
Culicada nemorosa, Theo., Mon. Cul. IV, p. 370 (1907).

Several specimens from Algeria (*Rev. E. A. Eaton*) in the British Museum seem to belong to this species. Some are very much paler than others, one having the thorax and abdomen almost entirely buff-coloured, yet I feel sure it is only a variety. This specimen agrees very well with Theobald's description of *G. maculosa*, which makes it seem possible that the latter is only an extreme form of *O. nemorosus*. The corresponding pale variety of *Stegomyia fasciata* (described by Mr. G. A. K. Marshall in the last number of this Bulletin) is common in Algeria, as is an ochreous form of *C. pipiens*.

Algeria.

4. **O. dorsalis**, Mg., Syst. Beschr. IV, p. 242 (1818).
Grabhamia dorsalis, Theo., Mon. Cul. III, p. 251 (1903).
Grabhamia subtilis, Ed. & Et. Serg., Bul. Mus. Paris XI, p. 240 (1905).
„ *willcocksii*, Theo., Mon. Cul. IV, p. 294 (1907).

The forms described as *G. subtilis* and *G. willcocksii* only differ in having the pale markings of the abdomen rather more extended than in typical *C. dorsalis*, and are evidently merely pale varieties of Meigen's species.

The ungual formula in all the specimens I have seen (including British specimens determined by Mr. Theobald as *G. dorsalis* and as *G. pulcripalpis*, and African specimens of *G. subtilis* and *G. willcocksii*) is: ♂ 2.1—1.1—1.1, ♀ 1.1—1.1—1.1, and it is most probable that errors of observation were made in compiling the table on p. 285 of vol. IV of the Monograph of the Culicidae.

I am not quite certain whether the species at present under consideration is really *C. dorsalis* or *C. pulcripalpis*, Rond., or whether these two names are synonymous. Whichever may be the case, it is certainly the same as our British species, which has always been known as *C. dorsalis*. It is curious, however, that

Austen (Entomologist, 1895, p. 228) overlooked the fact that the last joint of the hind tarsi is entirely white or whitish, while Theobald gives this as a character of *C. pulcripalpis* (introducing *C. pulcripalpis* as British on some specimens which showed the character markedly) but *not* of *C. dorsalis*. As, however, every specimen in the British Museum, British or otherwise, whether determined as *C. pulcripalpis* or as *C. dorsalis*, has the last joint of the hind tarsi whitish, I feel fairly sure that the fact has simply been overlooked. There is in Britain, so far as the National Collection is concerned, only one species of the *C. dorsalis* group, and it seems *à priori* more probable that this would be Meigen's species than Rondani's.

Mansonia arabica, Giles (J. Trop. Med. 1906, p. 130) is related to *O. dorsalis*, but can readily be distinguished by the much broader wing-scales, and there are other differences which show it to be distinct. *Culex arabicus*, Becker (Denkschr. k. Akad. Wiss. Math. Nat. kl. LXIX, 2, p. 140, 1910) is probably a homonym, as both appear to belong to the group *Grabhamia*.

Europe ; N. Africa.

5. **O. longisquamosus**, Theo. (*Grabhamia*), Ann. Mus. Nat. Hung. III, p. 102 (1905).

The ♂ and the hind ungues of the ♀ of this species have not been described, but it seems to belong to the *O. dorsalis* group, judging from the description.

Tunis.

6. **O. pulcritarsis**, Rond., Bull. Soc. Ent. Ital. IV, p. 31 (1872).
Culex leucacanthus, Lw., Beschr. Eur. Dipt. III, p. 1 (1873).
Culex mariae, Serg., Thèse de Paris, p. 64 (1903).
Grabhamia pulcritarsis, Theo., Mon. Cul. III, p. 244 (1903).

The specimens of *C. mariae* in the British Museum agree perfectly with the descriptions of *C. pulcritarsis* (by Ficalbi) and *C. leucacanthus*. The ungual formula in these specimens is ♂ 2·1-2·1-0·0, ♀ 1·1-1·1-0·0, and not as given by Theobald in Mon. Cul. IV., p. 285 ; the above is the formula given by Ficalbi for *O. pulcritarsis*. The species is quite distinct from *C. dorsalis*.

Europe ; Algeria.

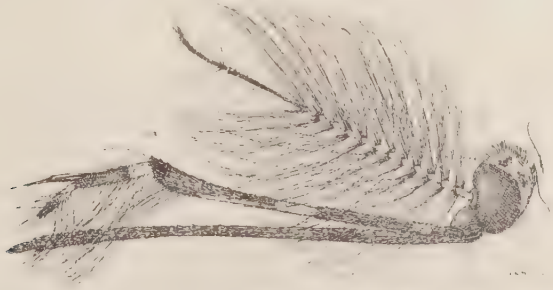

Fig. 1.—*Ochlerotatus hirsutus*, Theo., ♂ : side view of head, to show form and position of palpi.

7. **O. hirsutus**, Theo. (*Culex*), Mon. Cul. I, p. 392 (1901). (Fig. 1.)
Culex transvaalensis, Theo., Mon. Cul. III, p. 165 (1903).

The proboscis has a broad though ill-defined band. This is quite a typical member of the *Culicelsa* group, taking *C. taeniorhynchus*, Wied. (*nec* Arrib.), as the type.

S. Rhodesia ; Transvaal.

8. **O. durbanensis**, Theo., Mon. Cul. III, p. 246 (1903).
Grabhamia durbanensis, Theo., *l.c.*
„ *ocellata*, Theo., Mon. Cul. V, p. 284 (1910).
The type of *G. durbanensis* is a small specimen, but evidently the same as *G. ocellata*.
Natal; Delagoa Bay.

9. **O. nigeriensis**, Theo. (*Grabhamia*), Mon. Cul. V, p. 281 (1910).
Rather closely resembles *O. rigilax*, Skuse, from Australia and *O. noeturnus*, Theo., from Fiji, but has much more numerous light scales on the wings.
The ♂ of *C. rigilax* has only a protuberance representing the tooth on the larger claw of the mid tarsi; the ♂ of *C. nigeriensis* is not yet known.
S. Nigeria; N. Nigeria; Uganda; Nyasaland.

10. **O. quasiunivittatus**, Theo. (*Culex*), Mon. Cul. II, p. 32 (1901).
Culiciomyia dalzieli, Theo., Mon. Cul. V, p. 234 (1910).
An obscure species, and apparently rare, as only three specimens have been received at the British Museum which can be referred with certainty to it: a male and female from Salisbury, Mashonaland, and a female from Katagum, N. Nigeria. It is not a *Culiciomyia*, and though differing considerably in appearance from the three following species, must be included here on structural characters. It could hardly be mistaken for *C. univittatus*, with which Mr. Theobald has compared it.
N. Nigeria; S. Rhodesia; Natal.

11. **O. lateralis**, Mg., Syst. Beschr. I, p. 5 (1818).
Culicada lateralis, Theo., Mon. Cul. V, p. 310 (1910).
This European species has been recorded also from Algeria. It is very distinct and unlike any other European or African species with the exception of *O. ornatus*, Mg.

12. **O. caliginosus**, Graham (*Culex*), Ann. Mag. Nat. Hist. (8) v, p. 268 (1910).
Resembles *O. quasiunivittatus*, but the hind ungues of the ♀ are toothed and the head-scaling is different.
S. Nigeria.

13. **O. ochraceus**, Theo. (*Culex*), Mon. Cul. II, p. 103 (1901).
Culex pallidostriatus, Theo., Mon. Cul. IV, p. 410 (1907).
„ *parascelos*, Theo., Rec. Ind. Mus. IV, p. 18 (1910).
Mimeteculex kingii, Theo., Third Rep. Wellc. Lab. p. 258 (1908).
This species can be very easily recognised by the general yellowish coloration, legs striped with black and yellow, and the unequal hind ungues in the ♂. Similar leg-markings are however to be found in *Culex theileri* (= *pettigrewii*); whilst in *Pecomyia* and *Reedomyia lowisii* the ♂♂ have unequal hind ungues. I can see no difference between African and Indian specimens: the species, however, appears to be more common in Africa than in India. The unequal hind ungues of the male do not seem to the writer to form a sufficient reason for excluding the species from this genus.
N. Nigeria; Sudan; S. Rhodesia; India; Ceylon.

14. **O. leucarthrius**, Speiser (*Culex*), Kilimandjaro-Meru Exp., 1905-6, Dipt. Orth., p. 43 (1909).

Dr. Sjöstedt very kindly lent me the type of this species, and I can add the following notes to Dr. Speiser's description:

Head, bearing golden-yellow narrow-curved scales in the middle.

Thorax black, with brown scales, a short line of golden scales on the lateral margin in front, and a similar short line on each side of the middle line in front of the scutellum. Scutellum covered with narrow-curved bright golden-yellow scales; bristles golden.

Abdomen blackish, the segments with small lateral pale basal spots.

The hind ungues are missing, but it seems to be an *Ochlerotatus*; it is quite distinct from anything I have seen. The golden-scaled scutellum and the distinct pale band on the apex of the hind tibiae distinguish it at once.

German East Africa.

Genus THEOBALDIA, Neveu-Lemaire.

C. R. Soc. Biol., 1902, p. 1331.

Culiseta, Felt, New York State Mus. Bull. 79, p. 391c (1904).

This seems to be a well-marked genus. The claws and antennae are as in *Culex*, but the male palpi have the last two joints swollen, the terminal porrect and longer than the penultimate, being thus somewhat intermediate in structure between *Culex* and *Ochlerotatus*. The genus includes, besides the species mentioned in Theobald's monograph, *Culiseta absobrina*, Felt, and *Culicada morsitans*, Theo. The spotting of the wings, as might be expected, is not a constant generic character. Two species have been recorded from Africa.

Thorax with narrow white lines ... ... *spathipalpis*.
„ without white lines ... ... *annulata*.

1. **T. spathipalpis**, Rond., Bull. Soc. Ent. Ital. IV, p. 31 (1872).

Very variable in size, but easily recognised by the white lines on the thorax and the banded and spotted legs, which have a whitish ring just before the tip of the femora. The spots on the legs recall *Culex tigripes*, but the two can hardly be confused.

Cape Colony; Natal; Transvaal; N. Africa; Madeira: Europe.

2. **T. annulata**, Schrank, Beit. z. Naturg. 97, 70 (1776).

Algeria.

Genus TAENIORHYNCHUS, Arrib.

Rev. Mus. La Plata, II, p. 147 (1891).

Mansonia, Blanchard, C.R. Soc. Biol. 53, p. 1046 (1901).

This genus is accepted in its original signification, the principal character separating it from other allied genera being the peculiar formation of the ungues (♂ 2·0–2·0–0·0 or 1·0–1·0 0·0, ♀ 0·0 0·0–0·0). The wing-scales vary greatly in width from the very broad ones in the type *T. titillans*, Wlk. (=*taeniorhynchus*, Arrib., *nec* Wied.) to the narrow ones of *T. aurites* and its allies. The author fully agrees with Messrs. Dyar and Knab (Ent. News, July, 1910) that the genus *Mansonia* was a composite one, the Old World species belonging to a distinct genus, while *T. titillans*, *T. fasciolatus*, etc., are congeneric with the species erroneously added by Theobald to Goeldi's genus *Chrysoconops*; it also

seems probable that Dyar's *Coquillettidia* is not properly separable from *Taeniorhynchus*. The type species of the genus *Chrysoconops*, *C. fulvus*, Wied., has no connection with the African and Oriental species associated with it since the genus was founded: it does indeed resemble them in colour, but in structure it is nearer to *Ochlerotatus* than to *Taeniorhynchus*. In the present writer's opinion *Culex titillans*, Wlk., must be taken as the type of Arribalzaga's genus, because it is quite evidently the species which he describes, although he wrongly determined it as *C. taeniorhynchus*, Wied. On this view, which is the reverse of that held by Dyar and Knab, *Mansonia* becomes a synonym of *Taeniorhynchus* since *C. titillans* was also the type of *Mansonia*.

If *C. taeniorhynchus*, Wied., be taken as the type, Arribalzaga's careful and complete description of *Taeniorhynchus* becomes inaccurate in many important particulars; this course, if adopted, would necessitate sinking *Culicelsa*, Felt, as a synonym of *Taeniorhynchus*, and produce the anomaly of a genus none of whose members possessed the generic characters.

1. Violet-black species, thorax with pale scales in front ... *metallicus*.
   Abdomen and legs yellow or partly yellow ... ... 2.
2. Tibiae all black, abdomen all yellow ... ... *nigrithorax*.
   „ yellow, black-tipped, hind pair with a black ring in middle 3.
3. Wing scales both dark and light ... ... 4.
   „ „ all golden yellow... ... ... 3. *aurites*.
4. Thorax with the anterior two-thirds rather densely clothed with *pale* golden scales; joints of hind tarsi black at tips only *annettii*.
   Thorax uniformly clothed with sparse golden scales; joints of hind tarsi with broad black apical bands ... ... 5.
5. Thoracic integument black, abdomen all yellow ... ... *cristatus*.
   „ „ brown, abdominal segments with apical dark bands ... ... *fuscopennatus*.

1. **T. metallicus**, Theo. (*Culex*), Mon. Cul. II, p. 63 (1901).
   ? *Culex nigrochaetae*, Theo., ♂, Mon. Cul. II, p. 60 (1901).
   Banksinella metallicus, Theo., Mon. Cul. V, p. 408 (1910).
   Taeniorhynchus violaceus, Theo., Third Rep. Wellc. Lab., p. 262 (1908).
   Chrysoconops nigra, Theo., Mon. Cul. V, p. 434 (1910).

A very distinct species, easily recognised by the sub-metallic violet colour of the abdomen, femora and tibiae, and the shining whitish area on the front of the thorax.

Sudan; S. Nigeria; Angola; Uganda.

2. **T. nigrithorax**, Theo. (*Chrysoconops*), Mon. Cul. V, p. 439 (1910).
   Angola.

3. **T. aurites**, Theo., Mon. Cul. II, p. 209 (1901).
   Chrysoconops aurites, Theo., Mon. Cul. IV, p. 493 (1907).

Somewhat variable, some specimens showing dark apical patches on some of the abdominal segments, others having the abdomen entirely yellow. The anterior legs are sometimes without any dark scales, sometimes with the tips of the joints black and the whole of the last two tarsal joints brownish. *T. aurites*

has been wrongly recorded from the Malay States: the specimens are *T. ochraceus*, which differs from *T. aurites* in having no median black ring on the hind tibiae.

Sudan; Uganda; S. Nigeria.

4. **T. annettii**, Theo., Mon. Cul. II, p. 205 (1901).

Chrysoconops annettii, Theo., Mon. Cul. IV., p. 491 (1907).

Chrysoconops pseudoconopas, Theo., Mon. Cul. V., p. 443 (1910).

The specimens of *C. pseudoconopas* have the thorax very much rubbed, but I can see no difference between them and the types of *C. annettii*. All the specimens I have seen of *C. annettii* have the distinguishing characters given by Theobald for *C. pseudoconopas*. The dark scales on the wings occur chiefly in two tranverse bands, one before the tip of the wing and including the bases of the fork-cells, the other nearer the base. These bands are more conspicuous in some specimens than in others.

Uganda; S. Nigeria.

5. **T. cristatus**, Theo., First Rep. Wellc. Lab., p. 78 (1904).

Chrysoconops cristatus, Theo., Mon. Cul. IV., p. 491 (1907).

Sudan; N. Nigeria; S. Nigeria; Congo Free State (Katanga).

6. **T. fuscopennatus**, Theo., Mon. Cul. III, p. 265 (1903).

Chrysoconops fuscopenatus, Theo., Mon. Cul. IV., p. 492 (1907).

Culex drymoecius, Speiser, Kilimandjaro-Meru Exp., Dipt. Orth. p. 42 (1909).

Dr. Sjöstedt very kindly lent me a specimen of *C. drymoecius*, and it proved to be quite a typical *T. fuscopennatus*, though it certainly did not show the black abdominal spots mentioned by Dr. Speiser in his description. As, however, one or two males in the British Museum collection show these spots rather indistinctly, I think *C. drymoecius* can only be a variety of *T. fuscopennatus*.

Uganda.

Genus Mansonioides, Theo.

Mon. Cul. IV., p. 498 (1907).

Mansonia, Blanchard, C. R. Soc. Biol., LIII, p. 1046 (1901) (part).

As suggested by Messrs. Dyar and Knab, and noted above, the Old-World species of "*Mansonia*" cannot be kept in *Taeniorhynchus*. They resemble that genus in the peculiar structure of the claws, but the male palpi are so different that they are obviously distinct. The penultimate joint is thin and curved upwards, as in *Culex*, but the terminal joint is very short—$\frac{1}{8}$ to $\frac{1}{4}$ as long as the penultimate, and bent downwards at an angle with it. The terminal joint, in all the males I have seen (*M. uniformis*, *M. annulipes* and *M. annulifera*) is entirely covered with white scales. The resemblance in all structural details, and in many minor characters as well, between *M. annulifera* and *M. uniformis* is so great that I do not think it is possible, in this case at least, to regard the presence of flat or narrow-curved scales on the scutellum as a generic character. Probably *Etorleptiomyia* is a synonym, but as the male of *E. mediolineata* is unknown, I have adopted the later name *Mansonioides* for this genus.

1. Tarsi basally banded ... ... 2.
   First three tarsal joints apically banded ... ... *mediolineata*.
2. Abdomen with narrow apical pale bands, scutellum flat-scaled (?) ... ... *nigra*.
   Abdomen with apical lateral pale spots ... ... *uniformis*.

1. **M. (?) mediolineata**, Theo., First Rep. Welle. Lab., p. 71 (1904).
Etorleptiomyia mediolineata, Theo., *l.c.*
Sudan ; Transvaal.

2. **M. (?) nigra**, Theo., Second Rep. Welle. Lab., p. 80 (1906).
Mansonia (?) *nigra*, Theo., *l.c.*
It is not easy to see why Theobald did not include this species in *Etorleptiomyia*, as the heart-shaped scales are even more pronounced than in *M. mediolineata*. The unique type is now very badly damaged, but is clearly distinct from the other two species here associated with it.
Sudan.

3. **M. uniformis**, Theo. (*Panoplites*), Mon. Cul. II, p. 180 (1901) (fig. 2).
The following are included here :—
Mansonia africana, Theo., Mon. Cul. II, p. 187 (1901).
„ *major*, Theo., Mon. Cul. III, p. 270 (1903).
„ *nigerrima*, Theo., Mon. Cul. V, p. 450 (1910).
In the form *africana* the two greyish stripes which are present on the thorax of *M. uniformis* (typical form) are more or less broken up into spots. The names *major* and *nigerrima* have been applied to forms in which the reddish-brown

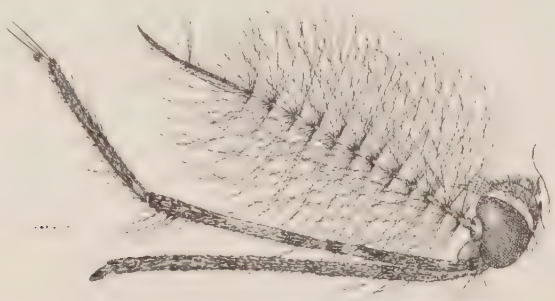

Fig. 2.—*Mansonioides uniformis*, Theo., ♂ ; side view of head. Note structure of palpi.

colour of the thorax is replaced by blackish, and the pale bands of the legs are narrower than usual. These forms, however, grade into one another, and it seems best to regard them as only varieties of *M. uniformis*.
Common throughout the Ethiopian, Oriental, and Australian regions.

Genus Culiciomyia, Theo.
Mon. Cul. IV, p. 227 (1907).
Neomelanoconion, Theo., Mon. Cul. IV, p. 514 (1907) (male only).
Pectinopalpus, Theo., Ann. Mag. Nat. Hist. (8) V, p. 375 (1910).

1. **C. nebulosa**, Theo., Rept. Liverp. S. Trop. Med., Mem. IV, App., p. x. (1901).
(?) *Culex invenustus*, Theo., *op cit.*, p. ix. (1901).
Culex cinereus, Theo., Mon. Cul. II, p. 58 (1901).
„ *nigrochaetae*, ♀, Theo., Mon. Cul. II, p. 60 (1901).
„ *pseudocinereus*, Theo., Mon. Cul. II, p. 62 (1901).
„ *freetownensis*, Theo., Mon. Cul. II, p. 69 (1901).

Neomelanoconion rima, ♂, Theo., Mon. Cul. IV, p. 514 (1907).
Pectinopalpus fuscus, Theo., Ann. Mag. Nat. Hist. (8) V, p. 375 (1910).
Culiciomyia uniformis, Theo., Mon. Cul. V, p. 230 (1910).

Dr. W. M. Graham first called the writer's attention to the probability of *Pectinopalpus fuscus* and *Culiciomyia freetownensis* being identical, and has suggested this in the "Bulletin of Entomological Research" (July, 1911, p. 132). At his suggestion I made preparations of the genitalia of a number of males, choosing specimens as different in size and in the amount of white on the abdomen as I could find. In none of these preparations could I see any specific differences; the smaller specimens were much less strongly chitinised, but this is only what might be expected in starved individuals. I also examined some hundreds of pinned adults, and though these varied greatly in size and in the extent of the whitish, lateral, abdominal spots, every gradation could be found between the various forms. In one case about 150 very small specimens were bred from the water in a pie-dish by Dr. T. F. G. Mayer, in Southern Nigeria, their size evidently being due to semi-starvation in the larval period. I have therefore come to the conclusion that there is only one variable African species of *Culiciomyia* (*C. dalzieli*, Theo., is a synonym of *Ochlerotatus quasiunivittatus*, Theo.), the forms or varieties of which are :—

α. *nebulosa*. Medium-sized specimens with obscure abdominal spots.
β. *cinerea*. Large specimens with distinct pale apical lateral spots on the abdominal segments.
γ. *pseudocinerea* (= *uniformis*, ? = *invenusta*). Large specimens with no pale abdominal spots.
δ. *freetownensis*. Small specimens with abdominal spots.
ε. *fusca*. Small specimens without abdominal spots.

As it would frequently be impossible to say whether a specimen were large or small, or even whether abdominal spots were present or not, since these are so variable in size, it does not seem advisable to retain these names in general use. There is some variation in the length of the fork-cells: two specimens from Prince's Island, Gulf of Guinea (*Dr. W. G. Ansorge*) have the first slightly shorter than the second. This is one of the many species which not infrequently have a bright green colour on the thorax or legs: this variation may possibly be due to something in the food of the larvæ.

In the Monograph of the Culicidæ (V, p. 239), referring to *C. freetownensis*, Theobald says "Perfect specimens show the venter of the abdomen to be white, except the apical segment, which is deep black." This remark only applies to some specimens wrongly determined as *C. freetownensis*, which are really *Eumelanomyia inconspicuosa*; the venter of *C. nebulosa* is all grey. *E. inconspicuosa* ♀ is very much like *C. nebulosa* to the naked eye, but has a black, shiny thorax, and a flat-scaled head. The thoracic integument of *C. nebulosa* and also the scales of the thorax, have a characteristic dull grey-brown appearance. The distinctions between *C. nebulosa* ♀ and *Protomelanoconion fuscum* ♀ have already been pointed out.

The type of *C. nigrochaetae* is not now in the British Museum, but it seems, from the description of the ♀, to have been only *C. nebulosa*. The number of

mid-scutellar bristles, as usual, is variable in this species, and as a matter of fact there are only 6, not 8, in the type of *C. cinerea*. I cannot help thinking, however, that the ♂ described as *C. nigrochaetae* was in reality *Taeniorhynchus metallicus*. *Culex invenustus* is probably the same species, but as I have not seen the type I have used the name *nebulosa*, which was published a page later in the same paper as *C. invenustus*. *C. invenustus* is said to have the thorax covered with flat scales (a character which is not found in any *Culex* I have seen), and to have the fore and mid femora swollen. If the former statement is an error, and the latter simply due to the femora having become flattened (a frequent occurrence), there cannot be much doubt that the specimen described as *C. invenustus* was a *C. nebulosa* var. *pseudocinerea*.

C. nebulosa appears to be one of the commonest of the CULICIDAE in West Africa, and extends into the Congo Free State, Uganda and Mashonaland.

Genus CULEX, Linn.

Syst. Nat. Ed. X (1758).

Culex, as now restricted, is one of the easiest genera to recognise in the male, but the females are sometimes not easily distinguished from those of *Taeniorhynchus*, etc. The genus includes only those species whose males have palpi and ungues similar in structure to those of *C. pipiens*. The mere upward curvature of the palpi may not be considered of importance, but as far as the writer has seen it seems to be perfectly constant, and when once understood forms the easiest character by which to distinguish a species of true *Culex* from one belonging to an allied genus. The structure and form of the ♂ palpi will be understood by a glance at the figure of *C. quasigelidus* ♂ (p. 258). The genus *Culex*, in this sense, includes *Lutzia*, Theo., *Aporoculex*, Theo., *Leucomyia*, Theo. (except *L. scapularis*), *Melanoconion*, Theo., *Heptaphlebomyia*, Theo., *Pseudoheptaphlebomyia*, Ventr., and some species of *Taeniorhynchus*, Theo. (*T. tenax* and *T. ager*), of *Grabhamia* (*G. jamaicensis*, etc), of *Culicada* (*C. quasimodesta* and *C. bicolor*) and of *Culicelsa* (*C. accraensis* and *C. annulirostris*) besides some small genera, such as *Lasioconops* and *Oculeomyia*, which were only founded on misconceptions: as regards the last named, contiguous eyes are found in nearly all the CULICALES, and I believe in most of the METANOTOTRICHA with the exception of *Eretmapodites*.

1. Proboscis and tarsi with pale bands, those on tarsi including both sides of joints (fig. 4, *a*) ... ... 2.
   Proboscis and tarsi unbanded ... ... 7.
2. Thorax with pale scales on the anterior two-thirds, or at least with a transverse pale band behind the middle (*Leucomyia*, Theo.) (fig. 5, *a*) ... ... 3.
   Thorax with almost uniform scales, at most with a pair of pale spots, abdominal segments with complete basal white bands ... 5.
3. Femora and tibiae with rows of sharply defined whitish spots (fig. 4, *a*) ... ... 1. *quasigelidus*.
   Femora and tibiae not spotted ... ... 4.
4. Abdomen almost unicolorous dark brown ... ... 2. *consimilis*.
   Adominal segments with both median basal and lateral apical triangular pale spots ... ... 3. *annulioris*.

5. Middle tibiae with a whitish lateral stripe (fig. 4, *b*); abdominal bands broadest in middle; band of proboscis broad and ill-defined 4. *duttoni.*

Middle tibiae unstriped; abdominal bands of equal breadth throughout; band of proboscis narrower and more clearly defined ... ... 6.

6. Femora not marbled ... ... 5. *thalassius.*

„ marbled (*i.e.*, with dark and light scales interspersed) 6. *somaliensis.*

7. Large species (usually 7 mm. or more in length); legs spotted 7. *tigripes.*

Medium-sized or small species; legs not spotted ... ... 8.

8. Legs striped somewhat as in *Ochlerotatus ochraceus* (on the fore legs the pale stripe is more or less broken up into spots, recalling *Culex tigripes*) (fig. 4, *c*) ... ... 8. *theileri.*

Legs not so marked ... ... 9.

9. Tibiæ striped with whitish (fig. 4, *d*) much as in *Culex duttoni*; seventh vein more distinct than usual, and generally bearing a few scales (*Heptaphlebomyia*, Theo.) ... ... 9. *univittatus.*

Legs uniformly brownish (except for pale knee-spots) ... ... 10.

10. Abdominal segments with pale markings basally ... ... 11.

„ „ „ „ apically ... ... 19.

11. Abdominal segments with basal banding in both sexes ... ... 12.

„ „ with basal lateral pale spots, in the ♂ often united in the middle line to form an irregular-shaped band ... ... 14.

12. Larger species, abdominal bands yellowish ... 10. *pipiens* group.

Smaller species, abdominal bands white ... ... 13.

13. Thoracic scaling uniformly reddish-brown ... ... 11. *decens.*

„ „ partly bronzy-brown and partly brassy, the latter often predominating ... ... 12. *simpsoni*

14. Thorax all pale-scaled, integument with lateral pale areas in front (fig. 5, *b*); abdominal spots large in both sexes ... ... 13. *pruina.*

Thorax not all pale-scaled, integument uniformly dark ... ... 15.

15. Thorax with two distinct pale areas near the middle (fig. 5, *c*) 14. *ornatothoracis.*

„ with uniform scaling or nearly so ... ... 16.

16. Venter entirely whitish ... ... 15. *guiarti.*

„ with dark bands on the apices of the segments ... ... 17.

17. Bases of fork-cells in ♀ equidistant from wing-base ... 16. *grahami.*

Base of first fork-cell nearer wing-base than that of second ... 18.

18. Larger species (usually 5–6 mm.); thorax with reddish brown scales 17. *zombaensis.*

Smaller species (usually 3–4 mm.); thorax with dark brown scales 18. *invidiosus.*

19. Abdomen with complete apical bands on at least some of the segments ... ... 20.

Abdomen with apical lateral spots ... ... 22.

20. Terminal joint of ♀ palpi short and thick ... ... 19. *salisburiensis*.
„ „ „ long and thin ... . 21.
21. Abdominal segments 2–7 with apical pale bands ... ... 20. *piliferus*.
„ „ 2–4 only with complete apical pale bands ... ... 21. *insignis*.
22. Thoracic integument blackish, scales blackish ... ... 22. *rima*.
„ „ reddish ... ... 22.
23. Scales and bristles of thorax reddish brown ... ... 23. *sergenti*.
„ „ „ black... ... ... 24. *rubinotus*.

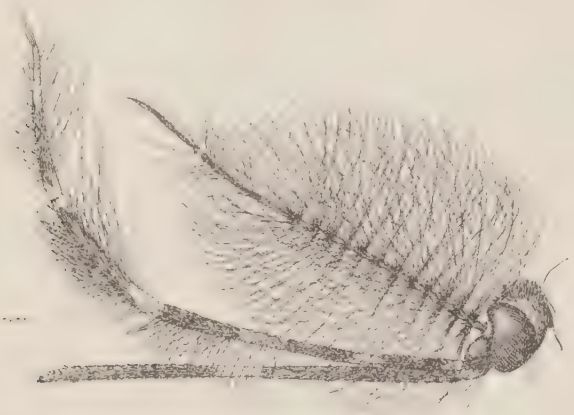

Fig. 3.—*Culex quasigelidus*, Theo. ♂; side view of head.
Note the long, hairy, upwardly curved palpi.

1. C. quasigelidus, Theo., Mon. Cul. III. p. 181 (1903) (figs. 3, 4*a* & 5*a*).
Lasioconops poicilipes, Theo., Rept. Liverp. S. Trop. Med., Mem. IV, App. p. ix (1901); Mon. Cul. III, p. 236 (1903).
Culex taeniorhynchoides, Giles, J. Trop. Med. 1904, p. 369.
Pseudoheptaphlebomyia madagascariensis, Ventrillon, Bul. Mus. Paris, XI, p. 427 (1905).
Taeniorhynchus tenax var. *maculipes*, Theo., First Rep. Welle. Lab., p. 79 (1905).
Aporoculex punctipes, Theo., Mon. Cul. IV, p. 316 (1907).
Leucomyia quasigelida, Theo., Mon. Cul. IV, p. 372 (1907).

The only species with which this can be confused is *C. tigripes*, which is larger, and has an unbanded proboscis and more numerous spots on the legs: the thoracic scaling is also quite different. *C. quasigelidus* has a very distinct appearance, as might be supposed from the fact that three genera have been erected for its special benefit. One of these, *Lasioconops*, was founded on a specimen which had a number of scales of some Lepidopteron adhering loosely to its abdomen. Some specimens of *Pseudoheptaphlebomyia* sent to the British Museum by Dr. Ventrillon are undoubtedly this species. In this and the two following allied forms the pale front two-thirds of the thorax is often more marked in the ♂ than in the ♀.

Gambia; N. Nigeria; S. Nigeria; Sudan; Uganda; Nyasaland Protectorate; Congo Free State; Angola; Madagascar.

2. **C. consimilis**, Newstead, Ann. Trop. Med. I, p. 23 (1907).
Culex tigripes var. *consimilis*, Newstead, *l. c.*
Culex pseudoannulioris, Theo., Mon. Cul. V, p. 333 (1910).
Taeniorhynchus tenax, Theo., Mon. Cul. III, p. 258 (part).

This is very closely allied to *C. quasigelidus*, and may perhaps be only a variety of that species: the difference in the leg marking, however, is so very striking that I prefer to consider them distinct. The four specimens of *C. pseudoannulioris* in the British Museum collection are all rubbed almost bare (they must have been described in that state), but I believe they can be safely included under *C. consimilis*. This species is no doubt the African representative of the Oriental *C. ager*, but it is difficult to accept Mr. Theobald's opinion that the two forms are conspecific: the true *C. ager* (= *Taeniorhynchus tenax*) is not African. Of the Oriental species there are two varieties:—

a. *C. ager*, Giles, Entomologist, XXXIV, p. 196 (July 1901).
Taeniorhynchus ager, Giles, *l. c.*
Taeniorhynchus tenax, Theo., Mon. Cul. II, p. 198 (Nov. 1901).
Oculeomyia sarawaki, Theo., Mon. Cul. IV, p. 515 (1907).

β. *C. ager* var. *sinensis*, Theo., Mon. Cul. III, p. 180 (1903).
Leucomyia gelida var. *sinensis*, Theo., *l. c.*
Leucomyia sinensis, Theo., Mon. Cul. V, p. 313 (1910).
Grabhamia ambigua, Theo., Mon. Cul. III, p. 248 (1903).
Grabhamia taeniarostris, Theo., Mon. Cul. IV, p. 299 (1907).

The var. *sinensis* is distinguished from the type form by the presence of basal as well as apical yellow bands on the abdominal segments.

In Mr. Newstead's series of *C. consimilis* are specimens of the preceding species, but the type has no spots on the legs.

Sierra Leone: Ashanti; S. Nigeria; Congo Free State; Sudan; Uganda; Natal.

3. **C. annulioris**, Theo., Liverp. S. Trop. Med., Mem. V, App. (1901).

This species is really very distinct, but has been confused with *C. duttoni*, one of the types (♂) of *C. hirsutipalpis* (= *duttoni*) actually being a specimen of *C. annulioris*. The markings of the thorax and abdomen, and the absence of the stripe on the tibiæ, will suffice to distinguish the present species from *C. duttoni*.

Gambia; S. Nigeria; Angola; S. Rhodesia; Transvaal.

4. **C. duttoni**, Theo., Rept. Liverp. S. Trop. Med. Mem. IV, App. p. v. (1901).
C. dissimilis, Theo., Mon. Cul. I, p. 376 (1901).
C. hirsutipalpis, Theo., Mon. Cul. I, p. 378 (1901).
C. anarmostus, Theo., Rept. Liverp. S. Trop. Med., Mem. X, App. p. vi. (1902); Mon. Cul. III, p. 170 (1903).
(?) *C. condylodesmus*, Grünb., Zool. Anz. 29, p. 385 (1905).
C. albovirgatus, Graham, Ann. Mag. Nat. Hist. (8) V, p. 264 (1910).

The pale stripe on the tibiæ of this species is sometimes rather obscure, but in conjunction with the broad band on the proboscis, the two pale spots on the

thorax (not always visible), and the rounded abdominal bands, it makes the species an easy one to identify. *C. univittatus* has the same spotted thorax, striped tibiæ and rounded abdominal bands, but differs in the unbanded proboscis and legs. The tibial stripe, too, in the last-named species is most distinct on the hind legs, while in *C. duttoni* it is particularly conspicuous on the middle legs. In the ♀ type of *C. dissimilis* I cannot make out the markings of the tibiæ, and the fork-cells are different; in fact this specimen looks much more like *C. thalassius* than *C. duttoni*, but since the males associated with it are undoubtedly all *C. duttoni* I have included *C. dissimilis* here as a synonym. I feel all the more confident in doing this, since Theobald (Entomologist, 1908, p. 107) has already pointed out that *C. hirsutipalpis* is only a large form of *C. dissimilis*. *C. hirsutipalpis* differs from the typical form in having some pale scales at the apices as well as at the bases of the abdominal segments, but there is no doubt

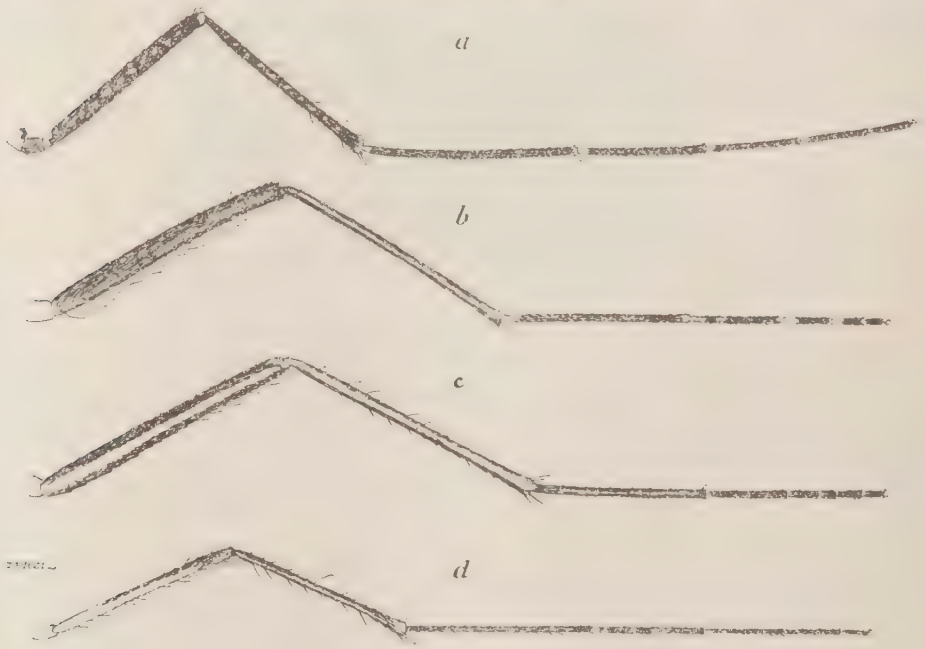

Fig. 4.—Legs of *Culex*: (*a*) Hind leg of *C. quasigelidus*, Theo.; (*b*) mid leg of *C. duttoni*, Theo.; (*c*) mid leg of *C. theileri*, Theo.; (*d*) hind leg of *C. univittatus*, Theo.

that this is only a variation, and it is hardly worth while retaining a separate name for it. *C. anarmostus* was described from a small specimen; this species, like many other mosquitos, varies very greatly in size. One specimen shows a remarkable abnormality in the neuration: the second vein is unbranched, and the upper branch of the fourth vein is only represented by a stump, so that the fork-cells are absent. *C. condylodesmus* is probably a synonym, but the description does not quite agree, as the band of the proboscis of the female is described as being broader and *more distinct* than in *C. dissimilis*.

Common throughout West Africa; Nyasaland; Transvaal.

5. **C. thalassius**, Theo., Rept. Liverp. S. Trop. Med., Mem. X. App. p. vii (1902); Mon. Cul. III, p. 168 (1903).
Culex bifoliata, Theo., J. Econ. Biol. I, p. 31 (1905).
Culicelsa accraensis, Theo., Mon. Cul. V, p. 317 (1910).
" *neotaeniorhynchus*, Theo., Mon. Cul. V, p. 320 (1910).

There is very little doubt that *C. bifoliata* is the same as *C. thalassius*, which is certainly conspecific with *C. accraensis*. The proboscis in both the specimens of *C. bifoliata*, contrary to Theobald's statement, is distinctly banded. I have examined the ♂ genitalia in these two specimens, and also in a specimen from Accra, and can only detect one "foliate plate" in any of them. There appears to be no difference in the thoracic marking between *C. accraensis* and *C. neotaeniorhynchus*—at any rate not sufficient to warrant the retention of the latter name as a distinct variety. This name is rather misleading, as *C. thalassius* does not belong to the *Culicelsa* group, the type of which is *C. taeniorhynchus*, Wied.

Gambia; S. Nigeria; Transvaal; Delagoa Bay.

6. **C. somaliensis**, Neveu-Lemaire, Arch. Parasit. 10, p. 254 (1906).
C. salus, Theo., Third Rep. Wellc. Lab. p. 256 (1909).
C. salsus, Theo., Mon. Cul. V, p. 338 (1910).

Very much like *C. thalassius*, but the first fork-cell is shorter and the femora are marbled. It bears an extremely close resemblance to the Indian *C. microannulatus*, and is quite possibly only a form of that species. As, however, I do not feel confident that they are the same—there is some difference in the shape and colour of the thoracic scales—I have not adopted the name *microannulatus* for the African species. The description of *C. somaliensis* agrees very well with specimens of *C. salus*, a large number of which have been received by the Entomological Research Committee from Somaliland.

7. **C. tigripes**, Grandpré, Les Moustiques (1900).
(?) *C. concolor*, R.-D., Mém. Soc. d'Hist. Nat. Paris IV, p. 405 (1825).
C. maculicrura, Theo., Mon. Cul. II, p. 34 (1901).
C. tigripes var. *fusca*, Theo., Mon. Cul. V, p. 394 (1910).

This species is very distinct from all other African *Culex* on account of its large size and spotted legs. It is, however, closely related to the Oriental *C. concolor*, the only constant difference I can detect being in the relative length of the fork-cells: in *C. tigripes* ♀ the base of the first fork-cell is nearer the base of the wing than that of the second, while in *C. concolor* the bases of both are almost equidistant from the base of the wing, that of the second fork-cell being if anything nearer the wing-base than that of the first. *C. tigripes* is also on the whole a darker insect, with less yellow on the abdomen, though there is a great deal of variation in this respect in both forms, some specimens of *C. concolor* being as dark as any *C. tigripes*, and having hardly any yellow scales on the abdomen. The last joint of the ♂ palpi in *C. tigripes* is generally dark, while in *C. concolor* it is nearly always light. Both forms have the same leg-markings, these being subject to some variation. Since there is this constant difference between the two forms (in neuration) I think *C. tigripes* must be regarded as a distinct species. To my mind it is an absolutely typical *Culex*.

It is curious to notice, that when a species is common to the Ethiopian and and Oriental regions, or when a pair of closely allied species occurs in the two regions respectively, the African form is often much darker in colour than the Eastern. The phenomenon does not seem to be confined to the CULICIDAE, as I have noticed it in the Tipulid *Conosia irrorata*, Wied.

The specimens mentioned by Theobald as having been taken in Australia belong to the *concolor* form. I have made several preparations of the male genitalia of each form, and can detect no difference whatever; the genitalia are of the ordinary *pipiens* and *fatigans* type. Theobald's *C. tigripes* var. *fusca* (Mon. Cul. V, p. 394) the male genitalia of which I have also examined, includes the darkest forms. It is certainly not, as I at first thought possible, a distinct species. *C. tigripes* is widely distributed over Africa.

8. **C. theileri**, Theo., Mon. Cul. III, p. 187 (1903).

C. pettigrewi, Theo., Rec. Ind. Mus. IV, p. 15 (1910).

A species very easily recognised by means of the striped femora. The co-type of *C. pettigrewi* in the British Museum exactly resembles *C. theileri*.

Transvaal; Madeira; India.

9. **C. univittatus**, Theo., Mon. Cul. II, p. 29 (1901).

Heptaphlebomyia simplex, Theo., Mon. Cul. III, p. 337 (1903).

Heptaphlebomyia montfforti, Ventrillon, Arch. Parasit. IX. p. 448 (1905).

A rather obscure species, until the striped tibiae are noticed. Some specimens recall *C. duttoni*, but they can always be distinguished by the unbanded proboscis and legs. The British Museum series of *H. simplex* consisted of 3 ♀ and 1 ♂ *C. univittatus* (including type ♀ of *H. simplex*) and one ♂ *C. decens* (labelled as type of *H. simplex*, and figured in Mon. Cul. IV, p. 533). The co-types of *H. montfforti* from Madagascar, which are in the British Museum collection, are certainly also *C. univittatus*. I do not believe the species is separable generically from *Culex*. The whitish spot on the apex of the tibiae is not more conspicuous in this species than in other members of the genus.

N. Nigeria; Angola; S. Rhodesia; Madagascar.

10. **C. pipiens**, Linn., Syst. Nat. Ed. X, p. 602 (1758).

Included here as varieties are:

i. *C. fatigans*, Wied., Auss. Zweif. Ins. p. 10 (1828). The stem of the first fork-cell is a little longer than in *C. pipiens*.

E. Africa; common almost everywhere in other parts of the tropics.

C. fatigans is said by Grünberg (Zool. Anz. xxix, 1905, p. 390) to be, with *Stegomyia fasciata*, F., the commonest Culicine in Kamerun and Togo. It seems as though some mistake must have been made, as *C. fatigans* is unrepresented in any of the large collections of mosquitos which have been received in England from West Africa.*

ii. *C. pallidocephala*, Theo., First Rept. Wellc. Lab. p. 73 (1904). The scales of the head are paler and the thorax is dark brown instead of reddish brown. The costal margin is darker.

Sudan; British East Africa.

* Since the above was written I have seen three specimens from Sokoto, N. Nigeria (*Dr. J. M. Dalziel*).

iii. *C stoehri*, Theo., Mon. Cul. IV, p. 419 (1907). The abdominal bands are more rounded, otherwise the specimen is like *C. pallidocephala*.
Nyasaland.

iv. *C. variоannulatus*, Theo., Mon. Cul. III, p. 198 (= *C. azoriensis*, Theo., Mon. Cul. III, p. 210, 1903). This is an almost typical *C. pipiens*; the females are rather shrivelled, hence the bands on the apical segments of the abdomen are not visible.
Cape Colony; Azores.

v. *C. pipiens*, L.
N. Africa; Europe; N. America.

11. **C. decens**, Theo., Rept. Liverp. S. Trop. Med. Mem. IV, App. p. vii, (1901).
C. masculus, Theo., Mon. Cul. II, p. 125 (1901).
C. minutus, Theo., J. Econ. Biol. I, p. 30 (1905).
C. nigrocostalis, Theo., Mon. Cul. V, p. 367 (1910).
C. lividocostalis, Graham, Ann. Mag. Nat. Hist. (8) V, p. 269 (1910).
Heptaphlebomyia simplex ♂, Theo., Mon. Cul. IV, p. 533 (1907).
Theobald states that in *C. masculus* the smaller claw on the fore and mid tarsi of the ♂ is not toothed; if this is the case (it is difficult to make out from the specimens), it is a very unusual variation. *C. masculus* seems otherwise identical with *C. decens*, which is a small and rather obscure species. Out of 18 specimens in the National Collection only 2 are females.
Sierra Leone; S. Nigeria; N. Nigeria; Sudan; Uganda; Transvaal.

12. **C. simpsoni**, Theo., J. Econ. Biol. I, p. 28 (1905).
Very much like *C. decens*, differing in the thoracic scaling.
Transvaal.

13. **C. pruina**, Theo., Rept. Liverp. S. Trop. Med. Mem. IV, App. p. viii, (1901).
C. pruinosus, Theo., Mon. Cul. II, p. 332 (1901).
C. pallidothoracis, Theo., Mon. Cul. V, p. 370 (1910).
Easily distinguished from all other African species by the pale lateral areas on the thoracic integument.
Ashanti; S. Nigeria.

14. **C. ornatothoracis**, Theo., Mon. Cul. V, p. 376 (1910).
Very near *C. grahami*. Both have the female palpi longer than usual; in this species they are quite one-fourth the length of the proboscis.
S. Nigeria; Gold Coast.

15. **C. guiarti**, Blanchard, Les Moustiques, p. 629 (1905).
C. viridis, Theo. (*nec* R.-D., 1827), Mon. Cul. III, p. 212 (1903).
C. neavei, Theo., Second Rept. Wellc. Lab. p. 76 (1906).
The green colour is certainly not a specific character; it not uncommonly occurs in many species, *e.g.*, *C. pipiens*, *C. grahami*, *C. pruina*, *Culiciomyia nebulosa*, and the Tipulid *Dicranomyia chorea*.
Sudan; Uganda; N. Nigeria; Gold Coast.

16. **C. grahami,** Theo., Mon. Cul. V, p. 628 (1910).
C. pullatus, Graham (*nec* Coquillett, 1904), Ann. Mag. Nat. Hist. (8) V, p. 265 (1910).

This and the two following species are extremely closely allied and perhaps should be classed together. Larger series and a closer study are, however, required. There is sometimes in *C. grahami* a more or less distinct rim of white scales to the eyes, recalling that of *Protomelanoconion fuscum*.

Gold Coast ; S. Nigeria ; Uganda.

17. **C. zombaensis,** Theo., Mon. Cul. II, p. 143 (1901).
C. quasiguiarti, Theo., Mon. Cul. V, p. 374 (1910).
C. quasiguiarti may be distinct, but I can see no character to separate it from *C. zombaensis*.

Uganda ; Nyasaland.

Fig. 5.—Dorsal view of thorax of, (a) *Culex quasigelidus*, Theo., ♀ ; (b) *Culex pruina*, Theo., ♀, the right half denuded to show the pale anterior patch ; (c) *Culex ornatothoracis*, Theo., ♀.

18. **C. invidiosus,** Theo., Mon., Cul. II, p. 329 (1901).
C. euclastus, Theo., Rept. Liverp. S. Trop. Med., Mem. X, App. viii. (1903).
C. chloroventer, Theo., Mon. Cul. V, p. 373 (1910).
(?) *C. aquilus*, Graham, Ann. Mag. Nat. Hist. (8) V, 1910, p. 266.

If the males described as *C. aquilus* do not belong to this species, there is no male in the collection.

Gambia ; Gold Coast ; Nigeria ; Congo Free State ; Uganda.

19. **C. salisburiensis,** Theo., Mon. Cul. II, p. 113 (1901).
C. bostocki, Theo., J. Econ. Biol. I, p. 29 (1905).

The type of *C. bostocki* has been lost, but the description leaves practically no doubt that it was only *C. salisburiensis*.

S. Rhodesia ; Transvaal ; Natal.

20. **C. piliferus,** Theo., Mon. Cul. IV, p. 274 (1907).
Maillotia pilifera, Theo. *l.c.*

This species closely resembles a small *Culex*, so is included here, as *Maillotia* only differs from *Culex* in the size of the scales on the head and thorax. ♂ unknown.

Algeria.

21. **C. insignis,** Carter, Bull. Ent. Res. II, p. 37 (1911).
Culiciomyia insignis, Carter, *l.c.*

Nyasaland; Uganda; Congo Free State (Colquilhatville); S. Nigeria; Sierra Leone.

22. **C. rima,** Theo., ♀, Mon. Cul. II, p. 327 (1901).
(Nec *Neomelanoconion rima*, Theo., ♂, Mon. Cul. IV, p. 514, 1907).
Melanoconion rimus, Theo., Mon. Cul. III, p. 240 (1903).

Culex rima was founded on female examples, the specimens which Theobald took to be the males are only *Culiciomyia nebulosa*: the ♂ of *C. rima* has not got the peculiar scales on the palpi or the flat scales round the eyes. Since the genus *Neomelanoconion* was founded on the male specimens in question it is a synonym of *Culiciomyia*.

Ashanti; S. Nigeria; Congo Free State; Uganda.

23. **C. sergenti,** Theo., Mon. Cul. III, p. 218 (1903).
Algeria.

24. **C. rubinotus,** Theo., Second Rep. Wellc. Lab., p. 76 (1906).
A single specimen, with very few scales left on the thorax or abdomen.
Sudan.

African Species not included in the preceding Tables.

C. aegypti, Linn., Hasselquists' Reise nach Palestina, p. 470 (1762). The description is as follows:—"*Culex aegypti* articulationibus candidis. Magnitudo Culicis vulgaris Linn. Syst. N. 1. Color ex fusco canus. Crura cana cum annulis candidis, parvis, circa articulationes et in articulis. Puncta candida ad marginem dorsi in corpore sub alis utrinque, plura, longitudinaliter sita. Annulus candidus ad basin thoracis, inter illum et corpus. Linea candida perpendicularis juxta oculos, utrinque una parva. Locus, Aegyptus, Culice communi rarior."

C. longefurcatus, Becker, Berl. Mitt. Zool. II, 3, p. 68 (1903). In his description Becker says "One sees no trace of scaling on the whole body." The name had therefore better be dropped altogether.

C. maculiventris, Meq., Dipt. Exot. Sup. I, p. 7 (1846). This evidently belongs to the *dorsalis* group, but the description is not full enough for purposes of tabulation.

C. rufinus, Bigot (Theo., Mon. Cul. II, p. 169); *C. pusillus*, Meq. (Theo., Mon. Cul. II, pp. 122, 166); *C. pallipes*, Meq., *nec* Mg. (= *C. melanorhinus*, Giles; Theo., Mon. Cul. II, p. 171). The descriptions of these species are inadequate.

Culicada quasimodesta, Theo., Ann. Mus. Nat. Hung. III, p. 88 (1905), and *Culex bicolor*, Mg., Syst. Beschr. I, p. 9 (1818), both seem to belong to *Culex* (s. str.) and apparently to the *C. pipiens* group. I have not seen specimens.

Culex didieri, *C. pygmaeus* and *C. zeltneri*, Neveu-Lemaire, Arch. Parasit. 1906. I have not seen specimens.

C. mundulus, Grünb., Zool. Anz. 29 p. 388 (1905). Said to be closely related to *Culiciomyia nebulosa*, but larger and paler. The description agrees fairly well with the latter species, except that the venter is described as having the segments with pale apical bands.

C. par, Newst. Ann. Trop. Med. I, p. 25 (1907). From the description this appears to be closely allied to *C. consimilis*, and is perhaps a rubbed specimen of that species.

C. laurenti, Newst., *l.c.* p. 24. The abdomen is described as uniformly pale brown. The size is not stated, nor the structure of the ungues.

Taeniorhynchus africanus, Neveu-Lemaire, Arch. Parasit. 10. p. 271 (1906). This cannot be a true *Taeniorhynchus*, as the female has toothed claws.

Boyeia mimomyiaformis, Newst., *l.c.* p. 34. Should probably be included in the genus *Ludlowia*; seems to be distinct from *L. pincerna*, which it most closely resembles, since the last *three* joints of the hind tarsi are described as *bronzy-ochreous*, the legs otherwise being unbanded.

Neomelanoconion palpale, Newst., *l.c.* p. 31. This species clearly does not belong to the genus *Neomelanoconion*, which is a synonym of *Culiciomyia*. The palpi of the male are figured as two-jointed; if this is really the case, the species cannot be a *Melanoconion*. The figures of the male palpus and wing and the description of the antennae suggest a *Ludlowia*.

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Note on some Culicidae described by Dr. K. Grünberg.—In the Zoologischer Anzeiger for 1905 (pp. 377–390), Dr. K. Grünberg described six new *Culicidae* from Kamerun and Togo, and the following notes on them may be useful.

1. *Myzomyia bisignata*.—This is in all probability a synonym of *M. rhodesiensis*, Theo. The third costal spot seems fairly distinct in Grünberg's figure, while in the type of *M. rhodesiensis* it is quite small.

2. *M. unicolor*.—Without a doubt the same as *M. umbrosa*, Theo. In publishing my note on this species in the July number of this Bulletin, I overlooked the fact that *M. nili*, Theo. (First Rep. Welle. Lab., p. 66, 1904) is another synonym: the types correspond in every particular.

3. *Myzorhynchus obscurus*.—Evidently the same species which Theobald has subsequently described as *M. strachani*. As Grünberg suggests, it is very likely only a variety of *M. barbirostris*.

4. *Stegomyia longipalpis*.—Redescribed by Graham as *S. pollinctor*. Transferred by Theobald to *Kingia*.

5. *Culex condylodesmus*.—Probably only *C. duttoni*. See above (p. 260).

6. *C. mundulus*.—Perhaps a *Culiciomyia*. See above (p. 266).

F. W. Edwards.

ON A NEW GENUS AND SPECIES OF SIPHONAPTERA FROM NYASALAND.

By the Hon. N. Charles Rothschild, M.A., F.L.S., F.E.S.

The Entomological Research Committee has received from Zomba four specimens of a new species of flea which is related to the genera *Leptopsylla*, Roths. (1911 ; type *musculi*, Dugès, 1832) and *Palaeopsylla*, Wagn. (1902 ; type *minor*, Dale, 1878 = *gracilis*, Tasch., 1880) but differs so much from the species belonging to these genera that it requires a separate genus. The species is especially remarkable for the development of its head and buccal organs (fig. 1). The mandibles as well as the labrum are very broad, particularly the former, and closely resemble those of *Spilopsyllus cuniculi*, Dale (1878), and the Sarcopsyllidae. This peculiar parallelism also obtains in the labial palpi, which show a reduction similar to that which occurs in the fleas mentioned, being but feebly chitinized and consisting of only three distinct segments. The size of the labrum and mandibles suggests that the species fixes itself to the host by means of these organs in the same way as *Spilopsyllus cuniculi*, i.e., more permanently than do the majority of fleas. The structure of the head bears out this surmise inasmuch as the buccal slit extends far upwards, the frons being short, which allows the piercing organs to assume an almost horizontal position when being driven into the skin of the host.

The new genus, which we propose to call *Chimaeropsylla*, gen. nov., is further characterised by the first segment of the mid tarsus being one-fourth shorter than the second, and the first of the hind tarsus as long as the second segment.

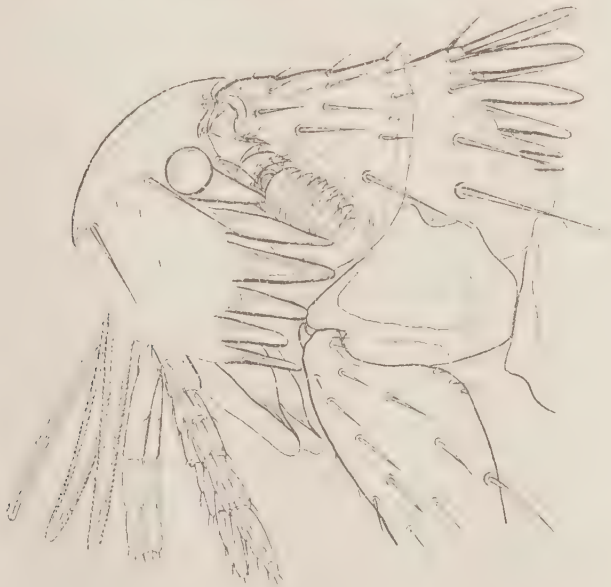


Fig. 1.—Head of *Chimaeropsylla potis* ♂.

Moreover, the abdomen is convex above in both sexes, being less slender than in *Leptopsylla* and *Palaeopsylla*. The stigmata are unusually large, especially that of the eighth abdominal segment. There is only one long antepygidial bristle on each side, accompanied by two minute hairs. The hind coxa bears a small comb on the inside. The short dorsal bristles of the tibiae do not form a regular comb as in *Leptopsylla musculi*. The fifth segment bears in all the tarsi four pairs of lateral bristles. There is a distinct eye at the base of the first genal spine.

Chimaeropsylla potis, sp. nov. (fig. 1).

♂ ♀. A fairly dark brown species. The bristles are rather short and those placed on the head and thorax are approximately thicker than is usual in the allied fleas.

Head.—The frons is evenly rounded, more strongly in the ♂ than in the ♀, and is only a little longer than the oral edge, the frontal angle lying about midway between the antennal groove and the ventral spine of the genal comb. The sides of the frons are flat, this part of the head being strongly compressed. There is one long bristle near the frontal corner, a shorter one in front of the eye, and one more behind the eye, there being a number of additional small bristles as shewn in the figure. The genal comb is vertical and consists of 6 spines, of which the second and the last are pointed in the ♂, while all have rounded tips in the ♀. The dorsal wall of the occiput is very strongly chitinised, this incrassation extending well downwards along the antennal groove. The occiput bears three rows of stout bristles, there being also a row of 4 or 5 small bristles along the antennal groove. The first segment of the maxillary palpus is the largest, the measurements of the 4 segments being 15-14-10-14 in the ♂, and 16-15-11-13 in the ♀. The labial palpus is a little shorter than the maxillary palpus and consists of three segments. The long first segment shews near its centre a trace of a division into two, but there is no hair at this place, as is usually the case at the apices of the segments of labial palpi. The tip of the labial palpus is obliquely truncate as in *Pulex* and its allies, and bears three small bristles. The mandible is proximally as broad as the apex of the first segment of the maxillary palpus. The bristles of the second segment of the antenna are all short. The eye is black and glossy, and is placed at the base of the uppermost spine of the genal comb.

Thorax.—The pronotum is dorsally only half as long as ventrally. It bears a row of ten bristles on the two sides together, and a comb of 12 spines. The dorsal spines of the comb are nearly as long as the ventral portion of the pronotum, while the lateral spines are quite short. The mesonotum is shorter than the occiput, and bears a row of ten bristles on the two sides together, and in front of this row about 10 short ones, besides a number of short dorsal bristles. There are on each side of the mesonotum, on the inner surface before the apex, a ventral spine and a dorsal one. The mesopleura have five small bristles. The metanotum is about as long as the occiput, and has a median row of short bristles and a postmedian row of long ones, each row containing ten on the two sides together. The metepisternum and the metasternum bear each one stout bristle, while the epimerum has two rows (♂, 4 and 5; ♀, 5 or 6 and 6 or 7.)

Abdomen.—The abdominal tergites ii to v or vi have each a row of ten bristles on the two sides together, there being also a row of small bristles on the first segment of the ♂ and segments i to v of the ♀, the numbers of this anterior row being in the ♀, 7–5–5–3–2 on the two sides together. The first tergite, moreover, bears an apical comb of 7 short spines, the second segment having 2 spines in the ♂ and 3 in the ♀, the third and fourth none in the ♂, but 2 and 1 respectively in the ♀. The antepygidial bristle is as long as the first hind tarsal segment. The sternites of segments iii to vii bear in the ♂ 2 bristles, the basal sternite having none, the numbers being 2 in the ♀ on the segments ii to v, 3 or 4 on vi, and 6 on segment vii.

Legs.—The comb of the hind coxa contains 7 or 8 spines placed in a row. The femora bear on the outside a single ventral bristle at some distance from the apex, and on the inside a smaller one nearer to the apex, the mid and hind femora not having any lateral bristles. The hind femur is remarkable for its shape, the ventral surface not being so strongly convex near the base as is the case in most fleas, but being thickest about its centre. The mid and hind femora have 7 dorsal notches, the first, second, fourth, and seventh (apical) notches bearing each a pair of bristles. There is a row of 8 lateral bristles on the hind tibia, and the longest dorsal apical bristle of this tibia is only half as long again as the tibia is broad; this bristle is stout and blunt, being less pointed and a little shorter than the longest ventral apical bristle. The bristles of the mid tarsus are short, the longest apical bristle of the first segment being only as long as the segment is broad. The longest bristle of the first segment of the hind tarsus is shorter than this segment, and the corresponding bristle of the second segment does not reach to the centre of the third segment. The most noteworthy feature of the tarsi is the shortness of the first segment in the mid and hind tarsi, the measurements of these tarsi being as follows:—

mid tarsus ♂, 14–19–13–7–20; ♀, 15–20–13–8–20.
hind tarsus ♂, 27–27–17–8–20; ♀, 30–29–17–9–22.

The four pairs of bristles of the fifth tarsal segment are lateral, the segment also bearing ventrally at the apex two short stout bristles, which are well separated from one another.

Modified segments.—♂. The eighth abdominal tergite is small, and the large stigma occupies the greater part of it. The eighth sternite is about as large as that of the seventh segment. It bears two or three bristles placed close together at the apical margin, the upper bristle being the largest. The clasper is elongate, its dorsal margin being excurved beyond the centre and then incurved, while the ventral margin is evenly and slightly excurved. A long bristle and a short one and two minute hairs are placed at the upper margin of the clasper, and four bristles at and below the apex, the upper one of them being the longest. The finger (fig. 2, F) is quite short. The manubrium (M) is long and slender. The ninth sternite has a broad vertical arm, which ends in a rather long point: the horizontal arm is constricted before the apex, and bears two apical bristles. The hind edge of the sensory plate of the ninth segment projects dorsally. The anal sternite bears on each side at the apex two long bristles and a shorter one. The clasping organs resemble those of *Leptopsylla aganippes*, Roths. (1904), to a certain extent, especially the clasper and finger.

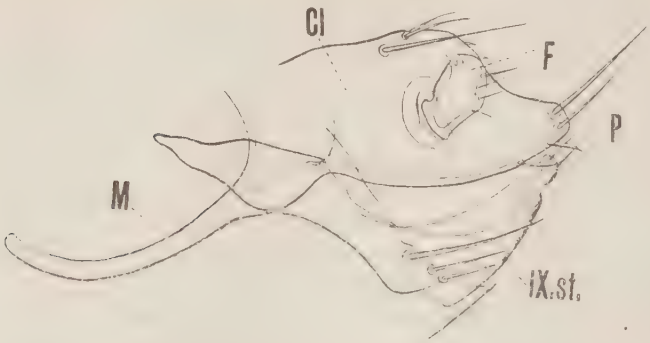


Fig. 2.—Clasping organs of *Ch. potis*, ♂. M., manubrium ; Cl., clasper ; F., finger ; P., process of the clasper.

♀. The seventh sternite is ventrally truncate, and laterally produced into a short obtuse lobe (fig. 3). The eighth tergite has no bristles above and below

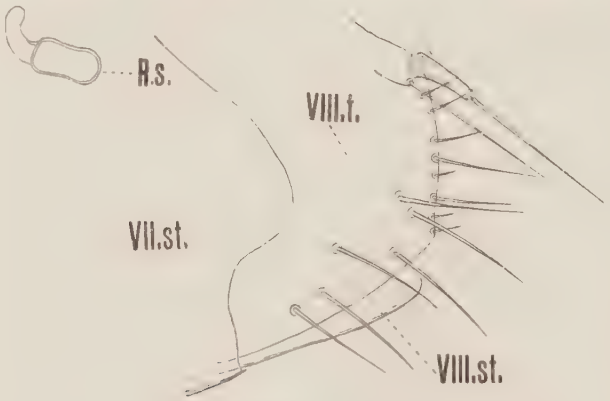
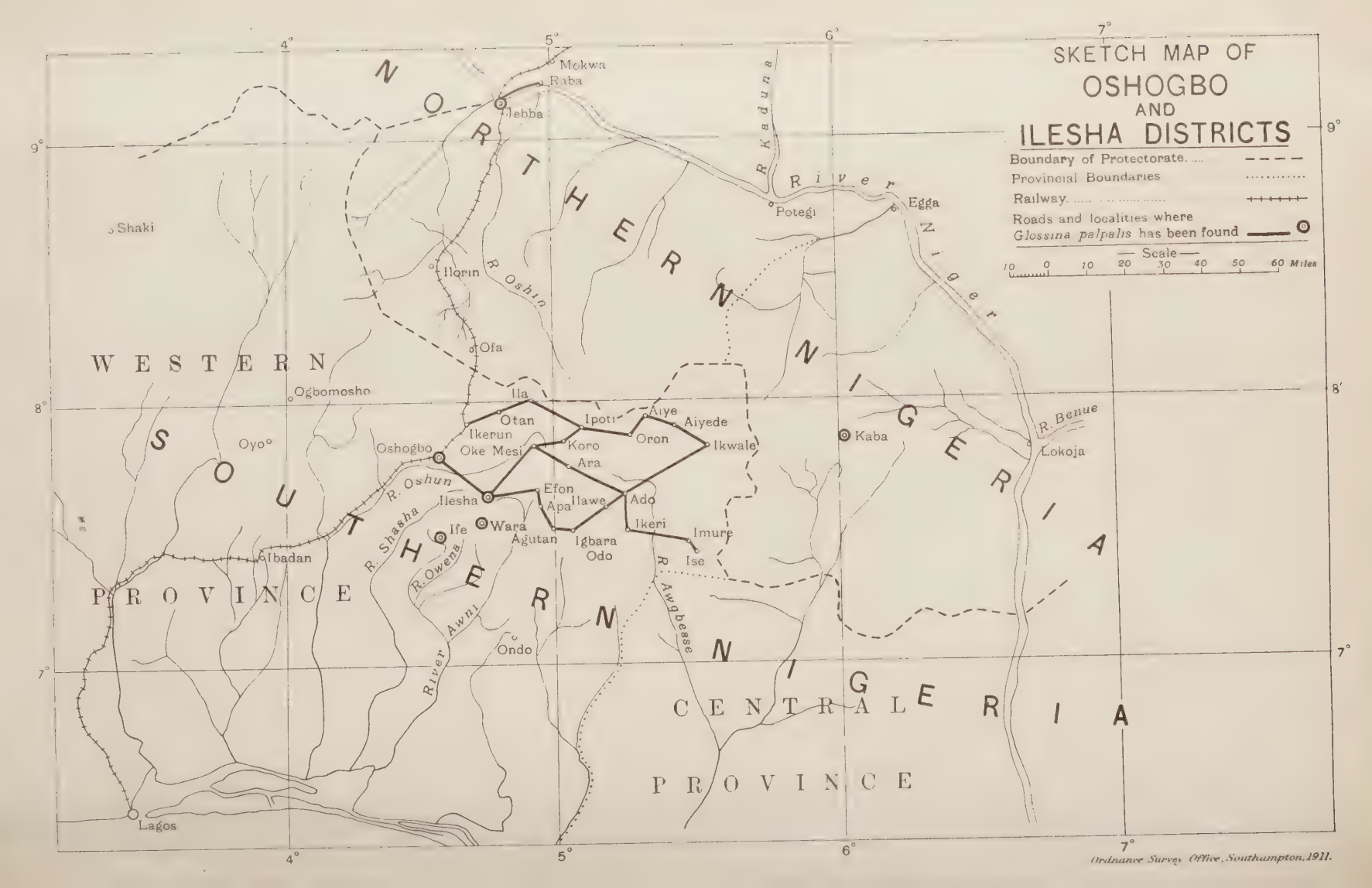


Fig. 3.—Abdominal segments VII. and VIII., and receptaculum seminis (R.s.) of *Ch. potis*, ♀.

the stigma, but bears about 6 bristles near the apical ventral margins on the outer surface, and about 9 at the apical edge. The stigma of this segment is as large as in the ♂. The eighth sternite is small, and has no bristles. The stylet is slender. The anal tergite bears dorsally on each side a long bristle which equals in length the apical bristle of the stylet. The *receptaculum seminis* is very small, the tail being of about the same length as the head, and the latter being thinnest centrally (fig. 3, R.s.).

Length, ♂ 1·5 mm., ♀ 1·9 mm.

One ♂ and three ♀♀ from Zomba, Nyassaland, taken by Dr. H. S. Stannus, in December, 1910, off the large elephant shrew, *Rhynchocyon cirnei*, Peters.


SKETCH MAP OF
OSHOGBO
AND
ILESHA DISTRICTS
Boundary of Protectorate.
Provincial Boundaries
Railway.
Roads and localities where
Glossina palpalis has been found
Scale
10 0 10 20 30 40 50 60 Miles
NORTHERN NIGERIA
SOUTHERN NIGERIA
CENTRAL NIGERIA
WESTERN PROVINCE
PROVINCE
Mokwa
Raba
Jebba
R. Kaduna
River
Poteg
Egga
R. Niger
Shaki
Ilorin
R. Oshin
Ofa
Ogbomosho
Oyo
Ila
Otan
Ipoti
Aiye
Aiyede
Ikerun
Oke Mesi
Oron
Ikwale
Koro
Ara
Oshogbo
R. Oshun
Ilesha
Efon
Apa
Ilawe
Ado
Ikeri
Imure
Ise
Ife
Wara
Agutan
Igbara
Odo
R. Shasha
R. Owena
Ibadan
River Awni
Ondo
R. Awgbesse
Kaba
R. Benue
Lokoja
Lagos
4°
5°
6°
7°
9°
8°
7°
Ordnance Survey Office, Southampton, 1911.

NOTES ON THE BLOOD-SUCKING FLIES OF OSHOGBO AND ILESHA DISTRICTS, SOUTHERN NIGERIA.

By Dr. T. F. G. Mayer, W.A.M.S.

(MAP.)

The Oshogbo and Ilesha districts of Southern Nigeria are contiguous and are situated in the north-east corner of the Western Province. They are bounded on the north and east by Northern Nigeria, on the west by the Oyo district, and on the south by the Ibadan and Ondo districts of the Western Province, and by a small part of the Central Province.

Politically, these districts are separate, the Government headquarters being at Oshogbo and Ilesha respectively, and it is in them that the majority of the biting flies mentioned below have been caught; at Ilesha by Capt. L. E. H. Humfrey and Capt. A. H. Blair, and at Oshogbo by myself.

The Oshogbo Residency is situated on a hill a mile from the native town. A clearing in the bush for about 100 yards round the house has been planted with Bahama grass.

The Ilesha Residency is also situated on the top of a hill, a very steep one, rising 700 feet above the surrounding country. It is about 2,000 feet above sea level. The base of this hill is thickly clothed with forest, but the summit has been cleared and planted with Bahama grass and gardens. The country to the north and east of Ilesha is very hilly and is clothed with thick forest, but west and south of Ilesha it is more open, having been cleared largely for farming, and is gently undulating. It will be seen on referring to the map that all this district is high ground, forming as it does the watershed for rivers flowing in every direction.

The tables below show the flies that have been caught in the two places. They are only of positive value, that is to say blanks must not be taken to mean that the fly is not present.

The rainy season begins in March and lasts till the end of October. No rain fell during November, December, January and February.

The collections of Capt. L. E. H. Humfrey and Capt. A. H. Blair, from Ilesha, have been sent during the year to the Entomological Research Committee, together with mine from Oshogbo, and all the identifications have been received from the Committee, with the exception of some specimens sent in June, July and August, 1910, to Dr. W. M. Graham, of the Medical Research Institute, Yaba, near Lagos. The results are shown in the tables following.

Ilesha.

	1910.							1911.				
	Collected by Captain L. F. H. Humfrey.							Collected by Captain A. H. Blair.				
	VI.	VII.	VIII.	IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.
	Rainy Season.					—	—	—	—	Rainy Season.		
Culicidae.												
Myzomyia funesta, Giles ...							+					
Stegomyia fasciata, F.		+			+		+			+		
„ *apicoargenta*, Theo. ...		+										
Culiciomyia nebulosa, Theo. ...		+	+						+			
Culex tigripes var. *fusca*, Theo.			+									
Eretmapodites quinquevittatus, Theo.				+								
Mucidus mucidus, Karsch ...			+									
Toxorhynchites marshalli, Theo.					+							
Tabanidae.												
Chrysops silacea, Aust.		+				+						
Haematopota lacessens, Aust. ...		+										
Rhinomyza stimulans, Aust. ...		+										
Tabanus ruficrus, P. de B. ...						+						
„ *kingsleyi*, Ric.									+	+	+	
„ sp. nov.									+			
Muscidae.												
Glossina palpalis, R.D.		+	+	+	+	+				+		
„ *longipalpis*, Wied. ...			+									
„ *fusca*, Walk.			+	+	+					+		

Oshogbo (collected by the Author).

Culicidae.												
Pyretophorus costalis, Lw. ...	+		+		+		+	+	+			+
„ *sp. nov.* (imperfect)							+					
Myzomyia funesta, Giles ...	+	+			+		+	+	+			
„ *umbrosa*, Theo. ...							+					
Myzorhynchus mauritianus, Gr.			+		+							
„ *paludis*, Theo. ...					+							
Stegomyia fasciata, F.					+							+
„ *africana*, Theo. ...			+	+								
Scutomyia sugens, Wied. ...												+
Mansonioides uniformis, Theo. ...		+	+	+	+		+	+				
Culiciomyia nebulosa, Theo. ...		+	+	+	+		+	+				
Culex decens, Theo.				+	+							
„ *tigripes* v. *fusca*, Theo. ...	+	+		+	+		+	+				
„ *duttoni*, Theo.	+	+			+		+			+	+	
„ *guiarti*, Blanch.					+	+						
„ *zombaensis*, Theo. ...			+									
Uranotaenia balfouri, Theo. ...					+							
Eretmapodites quinquevittatus, Theo.				+								
Ochlerotatus nigeriensis, Theo. ...								+				

	1910.							1911.				
	VI.	VII.	VIII.	IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.
	Rainy Season.					—	—	—	—	Rainy Season.		
TABANIDAE.												
Chrysops longicornis, F.							+					+
Hippocentrum versicolor, Theo.	+	+	+									
Haematopota decora, Walk. ...	+	+	+	+	+	+	+	+	+	+	+	+
Tabanus subangustus, Ric. ...		+									+	
" *quadrisignatus*, Ric. ...										+		
" *taeniola*, P. de B. ...										+		
MUSCIDAE.												
Glossina palpalis, R.D.		+	+						+	+		
Stomoxys nigra, Macq.	+	+	+	+	+	+						
HIPPOBOSCIDAE.												
Hippobosca maculata, Leach ...							+					

Stegomyia africana.—This mosquito bites only at dusk ; just before and after sunset. Directly darkness comes, it troubles one no more. This was particularly noticeable in Oshogbo in March when, for a time, it was the only mosquito present.

Mansonioides uniformis.—All specimens of this mosquito caught at Oshogbo after September, 1910, were affected with an immature parasitic mite. This species is common in Oshogbo in January and August. I could, however, get specimens whenever I chose in the Oshogbo Jail. I never succeeded in finding the larvæ.

Culex duttoni is very common in Oshogbo during October.

Tabanus subangustus.—This fly has also been caught by me in July, 1910, at Ibadan. It is very common in Oshogbo in May and October. The females are attracted by light and white clothing towards dusk and in the early morning.

T. thoracinus.—One specimen of this fly was caught on a window-pane in Ikirun Railway Station. It may have come into the district by train.

Hæmatopota decora.—This fly is very common in Oshogbo all the year round, but especially so in November. It does not bite man if animals are present and it seems to be especially fond of horses. It is most troublesome in the early morning and late evening.

Hippocentrum versicolor is the commonest biting fly in the Oshogbo district in June, July and August, excepting perhaps *Stomoxys nigra*. In my experience it is not seen during any other month.

Glossina palpalis is common all over the district in the rainy season. I have caught it when travelling along the following roads in July, 1910, viz :—the Oshogbo—Ilesha Road, and the Ikerun—Ila—Ipoti road.

Capt. Humphrey (then District Commissioner, Ilesha) caught this fly along the following roads in July, 1910: Ilesha—Efon—Ilawe—Igbara-odo—Ikere—Ado—Ipoti—Karo—Oke Mesi—Ilesha; and along the following roads in September, 1910: Ilesha—Efon—Apa—Akutan—Igbaraodo—Ilawe—Ado—Ikere—Ise, and on the Ado—Ara road.

Specimens of the fly were also sent me from Ife by Mr. Wheelwright, Foreman of Works. They were caught in September, 1910.

Sleeping Sickness.

Whether or not sleeping sickness occurs in these districts it is hard to say. My own opinion is that the disease does not exist. The Rev. J. Mackay, a missionary of the Church Missionary Society, who has been some seventeen years in these districts, says he remembers two cases that may have been sleeping sickness occurring five or six years ago. Not being a medical man he did not like to make any more definite statement. He has neither seen nor heard of any cases since. If the disease occurs there is no doubt that it is nothing like as prevalent as it is on the Gold Coast.

In this connection it may be mentioned that in these two districts the population is herded into large towns, into which only isolated specimens of *Glossina palpalis* stray with travellers and cattle. There are no small scattered villages.

Horse Sickness.

There is no doubt that within the last six years there has been an enormous increase of horse sickness. The Chiefs of Ila and Ife have complained to me that whereas in former days they could ride about in style, they now have to walk or hammock from place to place, because they can no longer keep horses for more than a few weeks.

The cause of this is no doubt the pacification of the country, and the subsequent introduction of infected horses from Northern Nigeria. It may be mentioned that the use of guns by the natives has led to the extermination of practically all the game in the district.

A Plant that kills Mosquito Larvae.

In attempting to breed out mosquitos from larvæ, I have two or three times been unsuccessful from a curious cause. A green gas-producing plant has grown in the water, attaching itself not only to the sides of the vessel, but also to the mouth-parts of the larvæ. A bubble of gas (whether it be oxygen or not, I do not know) forms and pulls the larva to the surface of the water, but into such a position that it cannot use its syphon tube. In this ridiculous position it dies miserably after making the most violent efforts to free itself from this inexorable bubble of air.

COLLECTIONS RECEIVED.

The thanks of the Entomological Research Committee are due to the following gentlemen, who have kindly presented collections of insects (received between 1st April and 30th June, 1911) :—

Dr. A. H. Barclay :—6 *Tabanus*, 192 *Glossina morsitans*, 4 *Stomoxys* and 57 Bombyliidæ ; from Nyasaland.

Capt. A. H. Blair :—10 *Tabanus*, 5 *Glossina*, 19 other Diptera and 2 Hymenoptera ; from Ilesha, Southern Nigeria.

Dr. H. A. Bödeker :—13 Culicidæ, 1 Hippoboscid, 3 other Diptera, 43 Lepidoptera, 4 Coleoptera, 2 Rhynchota, 2 Orthoptera and 5 Ticks ; from British East Africa.

Mr. W. S. Cody :—2 *Glossina* ; from British East Africa.

Dr. A. Connal :—37 Culicidæ, 78 Culicid larvæ, 5 Tabanidæ, 2 Hippoboscidæ, 29 Nycteribiidæ, 33 other Diptera, 10 Psychodid and 8 other Dipterous Larvæ, 2 Rhynchota and 25 Mallophaga ; from Lagos, Southern Nigeria. 362 Culicidæ, 5 *Tabanus* and 21 other Diptera ; from the Gold Coast.

Mr. J. A. de Gaye :—4 Diptera, 136 Lepidoptera, 12 Hymenoptera, 59 Coleoptera, 20 Rhynchota and 3 cocoons ; from Lagos, Southern Nigeria.

Mr. R. E. Drake-Brockman :—43 Culicidæ, 9 *Lyperosia*, 4 Hippoboscidæ, 13 other Diptera and 1 Hemipteron ; from British Somaliland.

Mr. J. H. J. Farquhar :—3 Diptera ; from Cross River, Southern Nigeria.

Mr. A. N. Foster :—1 Culicid, 11 Tabanidæ, 5 *Stomoxys*, and 34 other Diptera ; from Gambia.

Mr. C. C. Gowdey :—Numerous unpinned Culicidæ, 40 Tabanidæ, 15 *Glossina*, 2 *Dacus*, 32 other Diptera, 37 Lepidoptera, 66 Hymenoptera, 51 Coleoptera, 49 Rhynchota, several Coccidæ, 11 Orthoptera, 6 Odonata and 16 Ticks ; from Uganda.

Mr. F. J. Jackson, C.B., C.M.G. :—5 Cimicidæ ; from British East Africa.

Mr. W. A. Lamborn :—28 Tabanidæ, 23 *Glossina*, 10 other Diptera, 23 Coleoptera, 13 Hymenoptera, 16 Rhynchota and 50 fleas ; from Southern Nigeria.

Dr. P. H. Macdonald :—11 Culicidæ, 23 Tabanidæ, 5 *Glossina*, 2 *Auchmeromyia*, and 6 other Diptera ; from Bende, Southern Nigeria.

Dr. J. W. Scott Macfie :—14 Culicidæ, 44 Tabanidæ, 110 *Glossina*, 18 *Stomoxys*, 282 *Lyperosia*, 79 Hippoboscidæ, 332 other Diptera, 10 Hymenoptera and 2 Arachnida ; from Zungeru, Northern Nigeria.

Dr. T. F. G. Mayer :—55 Culicidæ, 5 Tabanidæ, 2 *Glossina*, 32 other Diptera, 10 Hymenoptera, 2 Neuroptera and 2 Rhynchota ; from Oshogbo, Southern Nigeria.

Mr. S. A. Neave :—60 Culicidæ, 1,071 Tabanidæ and a number of Tabanid eggs, 108 *Glossina*, 34 *Stomoxys*, 15 *Auchmeromyia luteola*, 16 Hippoboscidæ, 145 other Diptera, 4,665 Lepidoptera, 7,251 Hymenoptera, 12,133 Coleoptera, 17 Neuroptera, 3,049 Rhynchota, 15 Homopterous larvæ, 82 Odonata, 458 Orthoptera, 276 Lice, 1,172 Ticks, 55 Mites and 138 other Arachnida ; from German and British East Africa.

Dr. J. E. S. Old :—10 Culicidæ, 144 Tabanidæ, 146 *Glossina*, 35 Hippoboscidæ, 56 other Diptera, 31 Lepidoptera, 25 Hymenoptera, 13 Coleoptera, 9 Rhynchota, 114 Orthoptera, 28 Lice, 24 various larvæ and pupæ, 349 Ticks, 31 other Arachnida and numerous intestinal worms ; from Nyasaland.

Mr. W. H. Patterson :—100 Cecidomyidæ : from St. Vincent, British West Indies.

Dr. Meredith Sanderson :—4 *Chrysops*, 135 *Tabanus*, 115 *Hæmatopota*, 23 *Glossina*, 6 *Stomoxys*, 6 *Auchmeromyia luteola*, and 70 other Diptera ; from Nyasaland.

Mr. G. B. Simpson :—118 Lepidoptera and 7 Rhynchota ; from Zungeru, Northern Nigeria.

Dr. J. J. Simpson :—48 Culicidæ, 97 Tabanidæ, 195 *Glossina*, 111 *Stomoxys*, 2 *Lyperosia*, 5 *Auchmeromyia luteola*, 120 other Diptera, 22 Lepidoptera, 10 Coleoptera, 106 Hymenoptera, 12 Cimicidæ, 20 other Rhynchota, 15 Orthoptera, 10 Odonata, 1 Flea and 8 Spiders ; from Gambia.

The Royal Society (collected by Dr. G. D. H. Carpenter) :—65 Tabanidæ, 7 *Glossina*, 18 other Diptera, 13 Hymenoptera, 2 Coleoptera, 3 Orthoptera and 5 Rhynchota ; from Uganda.

Dr. H. S. Stannus :—15 Culicidæ, 7 Tabanidæ, 19 other Diptera, 4 Dipterous larvæ, 5 Lepidoptera, 6 Coleoptera, 5 Rhynchota, 1 Orthopteron, 8 *Hemimerus hanseni*, 8 Fleas, 7 Lice, 119 Ticks, 4 Mites and numerous intestinal worms ; from Zomba, Nyasaland.

Dr. Strathairn :—2 Culicidæ ; from Entebbe, Uganda.

Mr. A. M. D. Turnbull :—3 *Tabanus*, 2 *Auchmeromyia luteola*, 3 other Diptera, 100 Cimicidæ, 16 Fleas, 44 Anoplura, 35 Mallophaga and 129 Ticks ; from Zomba, Nyasaland.

Dr. R. van Someren :—26 *Tabanus*, 1 *Chrysops*, 30 *Hæmatopota*, 134 *Glossina*, numerous puparia of *Glossina*, 10 Hippoboscidæ, 16 other Diptera, 2 Lepidoptera, 3 Hymenoptera, 9 Coleoptera, 2 Orthoptera, 12 Rhynchota, several Coccidæ and 1 Leech ; from Toro District, Uganda.

NEW AFRICAN SPECIES OF TABANUS.—PART I.

By Ernest E. Austen.

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The types of the new species described in the following pages are in the British Museum (Natural History).

Tabanus necopinus, sp. n. (fig. 1).

♀.—Length (3 specimens), 14·75 to 16·5 mm.; width of head 5·4 to 5·8 mm.; width of front at vertex just under 1 mm.; length of wing 13 to 14·4 mm.

Fig. 1.—*Tabanus necopinus*, Austen, ♀. × 3.

Closely allied to Tabanus africanus, *Gray, and* T. latipes, *Macq., and—except for certain small differences in the wing-markings and the usually greater extent of the black lateral blotches on the abdomen, at any rate on the third and fourth segments—agreeing absolutely with these species in the coloration, appearance, and markings of the dorsal surface, as also in the uniformly black coloration of the legs, and in the shape of the front tibiae; distinguishable from both species mentioned by the ventral surface of the abdomen (except its basal angles and the hind margins of the second to the sixth segments inclusive) being entirely black.*

Head and *palpi* as in *T. africanus*; *antennae* as in the same species and in *T. latipes*, except that third joint is less elongate and less attenuated. *Thorax* as in the two species mentioned. *Abdomen*: dorsum as in the same two species, with the difference as regards the black lateral blotches already pointed out in the diagnosis printed in italics above; *venter*, except as stated in diagnosis and

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a narrow, ochraceous[*], lateral edging to anterior two-thirds of second segment, uniformly *shining black* and clothed with black hairs; hind margins of ventral scutes of second to sixth segments inclusive whitish grey, and clothed with silvery-white hairs. *Wings* hyaline, strongly marked with clove-brown or blackish brown, as shown in fig. 1, except that (at least in the case of the three specimens available for examination) the clear spaces in the first and second basal cells are a little smaller than would be supposed from the figure; transverse band, which covers discal cell, extending right across wing, as in *T. africanus* (not abbreviated before reaching hind margin as in *T. latipes*), distal margin of band less irregular than in wing of *T. africanus*; tip of wing as in *T. latipes*, *i.e.* merely with a grey border composed of minute hairs, the tips of the second longitudinal and anterior branch of the third longitudinal veins not, as in *T. africanus*, suffused with dark brown. *Squamae* and *halteres* as in *T. latipes*, though base of knobs and distal extremity of stalks of halteres sometimes dark brown.

Northern Nigeria and Sierra Leone Protectorate: type from Amageddi, R. Benue, Bassa Province, Northern Nigeria, 23. ix. 1909, and a second example from South Bornu, Northern Nigeria, between September and December, 1908 (*Dr. H. A. Fog, W.A.M.S.*); a third specimen from the vicinity of Wankefu, Karene District, Sierra Leone Protectorate, December, 1909 (*Dr. J. C. Murphy, W.A.M.S.*).

As will have been gathered from the above description, *Tabanus necopinus* occupies an intermediate position between *T. africanus*, Gray, and *T. latipes*, Macq. (that it is not, however, a mere variety or form of either of these species is proved by, *inter alia*, the difference in the shape of the third joint of the antennae). These three handsome, tawny-ochraceous species constitute a well-defined group, the members of which, owing to the characteristic pattern of their wing-markings, cannot be confused with any other of their congeners at present known. In tabular form their mutually distinctive characters may be indicated as follows:—

1.	Ventral surface of abdomen (except its basal angles and the hind margins of the second to the sixth segments inclusive) entirely black	*necopinus*, Austen.
	Ventral surface of abdomen not entirely black ...	2.
2.	Transverse band on wing reaching hind margin; tips of second longitudinal and of anterior branch of third longitudinal vein infuscated with dark brown	*africanus*, Gray.
	Transverse band on wing not reaching hind margin; tips of veins mentioned not infuscated with dark brown	*latipes*, Macq.

[*] For names and illustrations of colours, *see* Ridgway, "A Nomenclature of Colors for Naturalists" (Boston: Little, Brown and Company, 1886).

Tabanus copemani, sp. n.

♀.—Length (5 specimens) 12·4 to 14 mm.; width of head 4·2 to 4·8 mm.; width of front at vertex 0·6 to 0·75 mm.; length of wing 9·6 to 11·5 mm.

Medium-sized or smallish, dark-coloured species.—Dorsum of thorax blackish slate-coloured, somewhat shining, with two conspicuous, grey, admedian, longitudinal stripes; dorsum of abdomen clove-brown, hind border of first segment and greater part of second and third segments greyish cinnamon-rufous, hind borders of fourth and following segments greyish isabella-coloured and, except in case of last segment, clothed on each side with appressed, whitish hair; wings faintly tinged with drab, stigma narrow and elongate, mummy-brown; legs clove-brown or black, tibiae, except tips of middle and hind pairs and rather less than distal half of front pair, cream-coloured, and clothed with appressed, glistening white hairs.

Head grey (subcallus when denuded dark brown), face, jowls, and basioccipital region clothed with whitish hair; *front* of moderate breadth, about three and a half times as long as broad, inner margins of eyes bordering it almost or quite parallel, upper two-thirds of front clothed with short black hair, lower third, on each side of callus, clothed with short white hair; *frontal callus* oblong or roughly quadrate, often with its upper angles more or less rounded off or otherwise obliterated, dark brown or chestnut-brown, narrowly separated from eye on each side, and prolonged above into a raised median line; *palpi* dusky (mouse-grey or dark grey), clothed on outer side with whitish hair, terminal joint acuminate, moderately stout at base; first and second joints of *antennae* greyish clove-brown or brownish grey, clothed with black or blackish hair, third joint more or less chestnut, chestnut-brown, or cinnamon-rufous (sometimes entirely dark brown except at extreme base, sometimes entirely cinnamon-rufous except at extreme tip), expanded portion of third joint moderately broad, not elongate, terminal annuli fairly long. *Thorax:* dorsum clothed with erect, black or blackish hair, denser on scutellum, in front of suture also with minute, appressed, buff-yellow hairs; immediately above base of each wing is a small tuft of whitish hair; sides and front of dorsum grey, swelling in depression at each end of transverse suture drab-grey; dorsal stripes running from front margin to presutural groove, broadening out posteriorly and almost in contact; pleurae and pectus grey, clothed with whitish or blackish hair, either the one or the other colour sometimes predominating. *Abdomen:* hind border of dorsum of first segment clothed with glistening white hair; dorsum of second and third segments each with a large, though not sharply defined, clove-brown, median spot, resting on base but not reaching hind margin (occupying approximately anterior two-thirds of each segment); on each side of same two segments is a more or less distinct clove-brown blotch (often larger and more conspicuous in case of third segment), in contact with base, but not approaching hind margin nearer than median spot; immediately behind median spots on second and third segments is a patch of minute, appressed, glistening, whitish hairs, extending to hind margin in each case, while behind each of the lateral spots on the same segments is a larger, transversely elongate patch of similar hair, extending to the posterior angle; fourth and fifth segments each with a similar patch of minute, appressed, glistening, whitish hair on posterior half on each side, and also with a smaller,

more or less distinct patch of similar hairs in and on each side of middle line, close to hind margin; sixth segment except at base largely clothed with appressed, glistening, whitish hair; seventh segment, base of sixth, and first five segments except as already stated clothed with black hair; ventral surface of first three segments greyish russet or greyish cinnamon, clothed, like greater part of ventral surface of following segment with minute, appressed, whitish hair; ventral scutes of second to fourth segments inclusive with a clove-brown blotch in each basal angle; ventral scute of fourth segment, except hind margin and as already stated, greyish cinnamon-rufous or greyish brown; ventral scutes of last three (except hind margins of penultimate and antepenultimate) segments greyish clove-brown, clothed with black hair; hind margins of ventral scutes of second to sixth segments inclusive cream-coloured, clothed with whitish hair. *Wings:* veins dark brown; anterior branch of third longitudinal vein sometimes provided at base with a minute stump or backwardly directed appendix, which may vary in size in the two wings of the same specimen, or even be present in one wing and absent in the other. *Squamae* clove-brown or dark sepia-coloured, borders darker than disc. *Halteres* sepia-coloured. *Legs:* coxae grey and clothed with whitish hair, except distal extremities of front pair, which are blackish and clothed with black hair (in some specimens front coxae are almost entirely blackish and clothed with black hair); hind femora clothed below with whitish hair, otherwise femora, tarsi, and distal extremities of front tibiae clothed with black hair; on middle and hind tibiae the glistening white hairs extend on to the clove-brown tips; front tarsi enlarged, and the three middle joints expanded.

Northern Rhodesia and the Nyasaland Protectorate: type and three other specimens from the Feira District, Northern Rhodesia, 1911 (*E. A. Copeman*); one specimen from Liwonde, Nyasaland Protectorate, 19. I. 1911 (*Dr. J. E. S. Old:* presented by the Entomological Research Committee).

This species, with which the author has much pleasure in associating the name of one of its discoverers, is allied to *Tabanus claritibialis*, Ricardo, which hitherto has been met with only in the Nyasaland Protectorate. Apart, however, from the markings and very different coloration of the abdomen, which in *T. claritibialis* is unicolorous or nearly so, *T. copemani* is distinguished by differences in the shape of the third joint of the antennae, as also by its thoracic stripes. In the species described above the annulate portion of the third antennal joint is longer and the expanded part is usually shorter and broader than in *T. claritibialis*, in which the grey thoracic stripes, so conspicuous in *T. copemani*, are absent or vestigial.

Tabanus pullulus, sp. n.

♀.—Length (13 specimens) 11 to 13·4 mm.; width of head 4 to 4·6 mm.; width of front at vertex 0·6 to 0·8 mm.; length of wing 9·5 to 11 mm.

Medium-sized or small, blackish, unicolorous species, closely allied to Tabanus claritibialis, *Ric.—Dorsum of thorax and abdomen blackish slate-coloured, former, at least near front margin, with faint indications of grey longitudinal stripes, but otherwise thorax and abdomen entirely devoid of markings, except that hind margins of abdominal segments, excluding first segment and ventral scute of last, are pale;*

dorsum of thorax and abdomen clothed with minute, appressed, glistening, ochre-yellow or yellowish hairs, intermixed with black hairs, scutellum clothed mainly with black hairs; legs black or clove-brown, tibiae, except tips (and in case of front pair extreme base and greater part of under surface) cream-coloured, and clothed with short, glistening white hair.

Head grey (subcallus when denuded shining mummy-brown), face, jowls, and basioccipital region clothed with whitish hair; *front* of moderate breadth, inner margins of eyes bordering it parallel, vertex and rather less than middle third of front clothed with minute black hairs, space on each side of and immediately above callus, and between the two patches of black hairs just mentioned, clothed with minute white hairs; *frontal callus* mummy-brown or russet-brown, extending nearly from eye to eye, roughly ovate in outline, with its lower margin flattened and its upper extremity produced in middle line into a clove-brown or dark-brown ridge, which is usually low and rounded off rather than sharp; *palpi* dark grey, clothed on outer side with whitish hair, terminal joint acuminate, moderately broad at base; first and second joints of *antennae* cinnamon, clothed with black hair, base of third joint chestnut-brown or cinnamon-rufous, remainder of expanded portion of third joint dark brown, terminal annuli clove-brown, expanded portion of third joint of moderate breadth, annulate portion of third joint in length equal to about four-fifths of expanded portion. *Thorax:* pleurae and pectus grey, clothed with whitish hair; dorsum on and near front margin with commencements of two light grey, admedian, longitudinal stripes, sometimes also in same region with a trace of a much narrower median stripe of same colour; swelling in triangular depression at each end of transverse suture clothed with black hair, postalar calli and area immediately above base of each wing clothed with whitish hair. *Abdomen:* hind margins of second and following segments on dorsal side raw-umber-coloured; ventral surface of first four segments slate-grey, clothed with minute, appressed, glistening whitish hairs, ventral surface of last three segments blackish slate-coloured, that of last segment clothed entirely with erect black hair, ventral surface of antepenultimate segment clothed like preceding segments, that of penultimate segment clothed partly with black partly with glistening white hair; hind margins of ventral plates of second to sixth segments inclusive cream-buff, buff, or raw-umber-coloured. *Wings* faintly tinged with smoke-grey; *stigma* elongate, light mummy-brown or raw-umber-coloured, sometimes paler; veins mummy-brown. *Squamae* light sepia-coloured, borders darker. *Halteres* isabella-coloured, base of knobs dark brown. *Legs:* coxae grey, clothed with whitish hair; distal third of front tibiae black, extreme base of front tibiae and greater part of under surface above distal third clove-brown; tips of middle and hind tibiae clove-brown or dark brown; front tarsi somewhat enlarged and their third and fourth joints expanded.

Nyasaland Protectorate; Northern Rhodesia; German East Africa: type from Fort Johnston, South Nyasa, Nyasaland Protectorate, alt. 2,000 ft., 20. iii. 1910 (*Dr. A. H. Barclay:* presented by the Entomological Research Committee); two ♀♀ from the Zomba District, Nyasaland Protectorate, 1909 (presented by Dr. S. K. Norris); 1 ♀ from the vicinity of the Livilezi River, South Nyasa, Nyasaland Protectorate, 2. ii. 1910 (*Dr. J. B. Davey:* presented by the Entomological Research Committee); 5 ♀♀ from the Feira

District, Northern Rhodesia, 1911 (*E. A. Copeman*): 1 ♀ from Kilima-Njaro, German East Africa, 1887 (*F. J. Jackson, C.B., C.M.G.*) In addition to the foregoing, all of which are in the National Collection, the following three specimens from the Nyasaland Protectorate (*S. A. Neave*), which are in the possession of the Entomological Research Committee, have also been examined:—1 ♀ from the Upper Shire Valley, February, 1910; 1 ♀ from Fort Johnston, February, 1910; and 1 ♀ from the south-west shore of Lake Nyasa, March, 1910.

From *Tabanus claritibialis*, Ric., to which, as mentioned at the commencement of the diagnosis printed in italics above, the new species is closely allied, *T. pullulus* is distinguishable by the abdomen—instead of being (except at the distal extremity) cinnamon-rufous and clothed above exclusively with black hair—being entirely dark, and clothed on the dorsum, at least in part, with minute, appressed, glistening, ochreous hairs. As regards external *morphological* characters, the only noticeable difference exhibited by *T. pullulus* as compared with *T. claritibialis* is to be found in the greater length of the annulate portion of the third antennal joint.

Tabanus crocodilinus, sp. n.

♀.—Length (18 specimens) 9·6 to 12 mm.; width of head 3·5 to 4·4 mm.; width of front at vertex 0·6 mm. to just under 1 mm.; length of wing 8 to 9·75 mm.

Small, compactly built, dusky species, with rather broad head (which, viewed from above, is regularly convex in front and noticeably concave behind), a sharply defined and conspicuous, clove-brown frontal callus, which does not send off any kind of prolongation above, and with characteristically spotted abdomen.—Dorsum of thorax blackish slate-coloured, clothed with short, appressed, tawny-ochraceous hair, mixed with fine, erect, blackish hairs: dorsum of abdomen clove-brown, with a double series of transversely elliptical-oval or nearly circular, light-grey spots.

Head: front, from a little way above callus to vertex, mouse-grey, brownish grey, or brownish, clothed with very short, dusky or blackish hair: front immediately above callus yellowish grey on each side, and clothed with minute ochreous hairs; sub-callus drab-grey or smoke-grey: face, jowls, and basiocciptal region whitish grey and clothed with white hair: occiput light grey; *front* of moderate breadth above, narrower below; *frontal callus* normally quadrate, with its upper angles rounded-off, narrowly separated from eye on each side, in rubbed specimens sometimes somewhat more elongate; *palpi* small, pale cream-coloured, clothed on outer side with white hair, mixed in case of terminal joint with minute black hairs, terminal joint viewed from side broad at base and abruptly tapering to a point; *antennae* small, first and second joints cream-buff or buff, clothed above with minute black hairs mixed with glistening silvery hairs, third joint entirely ochraceous-rufous or ochraceous-buff, its expanded portion of moderate breadth, and the angle on its upper margin usually neither sharp nor prominent. *Thorax:* dorsum not striped, though the beginnings of three narrow grey stripes can sometimes be seen next front margin; a few whitish hairs on postalar calli, and above base of each wing: swelling occupying

triangular depression at each end of transverse suture drab-grey and clothed with black hair; pleurae and pectus light grey (upper portion of mesopleura drab-grey), clothed with greyish white hair. *Abdomen:* dorsum of first segment grey on basal angles, and with a small patch of pale yellowish hair in middle line, just beyond scutellum; distal angles of dorsum of first segment, and sides and distal angles of dorsum of five following segments clothed with pale yellowish hairs, which on second to sixth segments inclusive extend inwards along hind margins; dorsum of second segment grey at extreme base; hind margins of second and following segments isabella-coloured or smoke-grey; dark portion of dorsum clothed for most part with minute black hairs, but on second to sixth segments inclusive also clothed in and adjacent to middle line with minute, appressed, pale yellowish or ochreous hairs, which on the second segment of a specimen from the Anglo-Egyptian Sudan form a pale median triangle, the base of which rests on the hind margin while the apex extends to the grey anterior border; paired spots (described in diagnosis above) clothed with minute, appressed, pale yellowish hairs, and situate on dorsum of second to fifth (or sixth) segments inclusive, one spot midway between middle line and lateral margin on each side; on the second to the fourth segments inclusive the spots are not in contact with either the front or the hind margins, but on the fifth segment (and also, when present, on the sixth) they usually touch the front margin; when elongate, the spots usually have their longer diameters at right angles to the middle line of the abdomen, in which case there is often an indistinct greyish connection between the spots belonging to the same pair; occasionally the spots on the second segment are slightly oblique (in the case of the specimen from the Anglo-Egyptian Sudan referred to above the spots on the second and third segments are obliquely oval); *venter* light grey, clothed, except last segment, with whitish hair, hind margins of second and following segments, except last, cream-coloured. *Wings* hyaline, veins (except costa and first longitudinal, which are mummy-brown) pale cinnamon; *stigma* elongate, raw-sienna-coloured or paler, inconspicuous. *Squamae* pale isabella-coloured. *Halteres:* stalks cream-buff, darker at extremities; knobs cream-coloured, isabella-coloured above. *Legs:* front coxae drab-grey, middle and hind coxae grey, all coxae, like all femora and tibiae, clothed with silvery-white hair, which in case of tibiae is mixed with black hairs; femora and tibiae ochraceous-buff, femora greyish pollinose, sometimes more or less grey, hind tibiae ciliated on outer side with silvery-white hairs mixed with black hairs; front tarsi dark brown, not noticeably expanded, first joint (except distal extremity) and extreme bases of the three following joints usually cinnamon-coloured; middle and hind tarsi pale cinnamon or buff, tips of joints mummy-brown, last joint usually entirely or almost entirely mummy-brown, sometimes dark brown.

Nyasaland Protectorate and the Anglo-Egyptian Sudan: type and sixteen other specimens (five of them presented to the National Collection by the Entomological Research Committee) from the Lufira River, North Nyasa, Nyasaland Protectorate, 6. viii. 1909, "on crocodile" (*Dr. J. B. Davey*); one specimen from Dufile, Mongalla Province, Anglo-Egyptian Sudan, 19. vi. 1911, "on cattle" (*H. H. King*).

Tabanus crocodilinus, which should be readily recognisable by means of the characters mentioned in the diagnosis printed in italics above, does not appear to be especially closely allied to any one of its congeners at present described. Although the absence of an offshoot or upwardly directed prolongation from its single frontal callus would place it in Surcouf's "Fifteenth Group," the fact that its front tibiae are not swollen—apart from all other characters—is alone sufficient to show that the new species would be entirely out of place in this division, which consists solely of *Tabanus maculatissimus*, Macq. and *T. irroratus*, Surcouf.

Tabanus pertinens, sp. n. (fig. 2).

♂ ♀.—Length, ♂ (16 specimens) 11 to 13·6 mm., ♀ (30 specimens) 8·8 to 14 mm.; width of head, ♂ 4 to 4·5 mm., ♀ 2·75 to 4·4 mm.; width of front of ♀ at vertex just under 1 to 1·25 mm.; length of wing, ♂ 9 to 10·25 mm., ♀ 7 to 11·2 mm.

Fig. 2.—*Tabanus pertinens*, Austen, ♀. × 4. *a*, head of ♂ from above. × 4.

Small or smallish, greyish, elongate species, with eyes in ♂ densely clothed above with fine, short, pale hair, front in ♀ broad, frontal callus in ♀ absent or scarcely noticeable, and with dorsum of abdomen in both sexes marked (*as shown in* fig. 2) *with four series of elongate black or clove-brown marks, forming four narrow longitudinal stripes, which are more or less interrupted on the hind margins of the segments.*

♂.—*Head* (fig. 2a): wide (greatest transverse diameter of each eye considerably longer than greatest vertical diameter), light grey, face, jowls, and basi-occipital region clothed with whitish hair: *frontal triangle* raw-umber-coloured, shining (dull smoke-grey pollinose immediately above bases of antennae and also at apex); *eyes* (*cf.* fig. 2a) with a bluntly fusiform, horizontal area (bisected by the impressed median line formed by the division between them) of larger

facets, which even in dried specimens differ in colour from the remainder, the fusiform area being usually paler (drab-grey or smoke-grey, fawn-coloured, or chocolate), margined with dark brown, and marked with a curved transverse band of dark brown, which extends almost from end to end of the area; longer hair on eyes confined to fusiform area, below which the hair is so short and sparse as to be scarcely noticeable under a hand-lens magnifying 15 diameters (nominal): proximal joint of *palpi* mouse-grey (cream-buff at extreme tip), clothed with whitish hair, distal joint cream-coloured, oval or short ovate, clothed with long, outstanding whitish hair, mixed at and near tip of joint with minute black hairs: *antennae* small, first and second joints smoke-grey, upper distal angle of first joint considerably developed, prominent, and clothed with minute black hairs or bristles, third joint ochraceous-buff (terminal annulus dark brown), expanded portion viewed from side fairly broad, its upper margin produced into a prominent angle at about its middle point, the four distal annuli slender and together approximately equal to the expanded portion of the third joint in length. *Thorax*: ground colour blackish slate, pleurae and pectus light grey pollinose, swelling occupying depression at each end of transverse suture greyish fawn-coloured or smoke-grey, and clothed partly with blackish partly with greyish hair; dorsum longitudinally striped with grey, as in ♀ (*see* fig. 2), and clothed with fine, silky, erect, yellowish hair, mixed with fine blackish hair, pleurae and pectus clothed with outstanding greyish white hair. *Abdomen* narrow and elongate, gradually tapering to a point; dorsum marked as in ♀, the elongate marks forming the dark stripes clothed with fine black hair, the intervening light grey stripes clothed with fine cream-coloured hair, sides of dorsum clothed with long, fine, whitish hair; venter dark grey, covered with light grey pollen, and clothed (except last two segments, which bear coarse, erect, black hairs) with whitish hair; hind borders of ventral scutes of second to sixth segments inclusive cream-buff; ventral scutes of second and third, or second, third, and fourth segments sometimes each with a more or less indistinct, elongate, greyish fawn-coloured area near lateral margin on each side. *Wings* hyaline, veins for most part mummy-brown; *stigma* so pale as to be inconspicuous. *Squamae* semi-opaque waxen-white, borders cream-buff. *Halteres* cream-coloured. *Legs*: coxae grey, clothed with whitish hair; femora grey, at least at base, often more or less greyish ochraceous-buff at and towards distal extremities, clothed below and posteriorly with long, whitish hair; tibiae greyish ochraceous-buff (anterior surface of front pair sometimes mainly mouse-grey or dark grey), tips of middle and hind pairs usually brownish or dark brown, all tibiae clothed on anterior, upper, and posterior surfaces with minute, appressed, silvery hairs, which on upper surface are mixed with minute black hairs; front tibiae sparsely fringed antero-exteriorly with longer black hairs mixed with similar whitish hairs, middle tibiae with a loose, irregular fringe of fine, whitish hairs, on outer and inner surfaces, hind tibiae densely fringed on both inner and outer sides with long, fine, silvery-white hair, the fringe on the inside being the longer, and that on the outside mixed with a certain number of fine black hairs; tarsi dark brown (first joint of middle and hind pairs sometimes more or less ochraceous-buff, except at distal extremity), clothed above with minute, appressed, silvery white

hairs, which, on middle and hind tarsi, are mixed with minute black hairs : distal extremities of joints of front tarsi fringed on each side with longer hairs.

♀. —*Head* light grey, face, jowls, and basioccipital region clothed with whitish hair : *front* narrower below (at lower extremity about four-fifths as wide as at vertex), upper two-thirds (except sides) clothed with short, erect, blackish hairs, lower third clothed with minute, appressed, Naples-yellow hairs, which also extend on to sides of upper portion : just below middle of front most specimens exhibit a mummy-brown mark, which is in contact with the eye on each side and is sometimes shaped like a wide V or nearly straight transverse band, but more usually consists of a downwardly directed median portion (generally the only part of the mark visible when the insect is viewed directly from above*), connected with each eye by a curved, transverse offshoot : *frontal callus* in absolutely undenuded specimens entirely concealed by the grey pollinose covering of the head, but when exposed flat, small, yellowish horn-coloured and usually semicircular in outline, with its straight edge resting on the upper margin of the subcallus, and elsewhere with a narrow mummy-brown border, which is widely separated from the eye on each side : in specimens in which the frontal callus is not fully exposed, its position is nevertheless often indicated by its mummy-brown upper margin ; *eyes* sparsely clothed with minute pale hairs, just visible under a hand-lens magnifying 15 diameters (nominal) when the eyes are brightly illuminated and viewed against a dark background ; *palpi* cream-coloured, proximal joint clothed with long, whitish hair, distal joint viewed from side shortly acuminate (swollen or strongly swollen at base and tapering quickly to a point), clothed on outer side with minute, appressed, silvery white hairs mixed with minute black hairs, and at base below with longer whitish hair ; *antennæ* agreeing generally in coloration with those of ♂, but expanded portion of third joint usually broader (sometimes much broader and dark brown or brownish above), and annulate portion of same joint stouter. *Thorax* : ground colour, pleurae, and pectus as in ♂, except that ground colour of distal extremity of scutellum is chestnut or cinnamon-rufous ;† dorsum greyer than in ♂, longitudinally striped with light grey as shown in fig. 2, the paired, admedian, grey stripes usually broader than in ♂ ; hairy covering of dorsum consisting of short, appressed, ochre-yellow or pale ochre-yellow hairs, mixed with longer and more erect blackish hairs, and with short black hairs on (at least posterior extremities of) admedian dark stripes, and on median portion of basal half of scutellum. *Abdomen* (*cf.* fig. 2) : grey stripes on dorsum clothed with minute, appressed, cream-coloured or pale yellow hairs, dark markings clothed with black hairs of a similar character ; on the penultimate and antepenultimate segments (frequently also on others as well) the pale yellow hairs on the grey markings are freely interspersed with longer black hairs ; dorsal surface of last segment almost exclusively if not entirely clothed with black hair ; sides of dorsum fringed with whitish hair, which however is not so long as in ♂ ; ventral surface of first

* It is this median portion which is shown in the figure on p. 286, where it appears somewhat too dark ; it must not be mistaken for the frontal callus.

† A trace of chestnut in the ground colour is often seen at the tip of the ♂ scutellum also.

six segments light grey, clothed with short, appressed, glistening, cream-buff or pale yellowish hairs, mixed on sixth segment and also to some extent on fifth with black hairs; ventral surface of seventh segment dark grey, and, as usual, clothed with coarse, erect, black hairs; hind borders of ventral scutes of second to sixth segments inclusive as in ♂. *Wings*, *squamae*, and *halteres* as in ♂. *Legs*: coxae light grey or smoke-grey, clothed with whitish hair; femora and tibiae greyish buff (tibiae brownish at tips), clothed above with minute, appressed, silvery-white hairs, femora clothed behind and below with longer, whitish hair, outer side of front tibiae sparsely fringed with blackish hairs, hind tibiae fringed as in ♂, except that the hairs are much shorter; tarsi brownish or dark brown, first joints of middle and hind pairs more or less ochraceous-buff except at tips, front tarsi loosely fringed on each side with blackish hairs, and their second, third and fourth joints somewhat expanded.

Northern Nigeria; Anglo-Egyptian Sudan; East Africa Protectorate; German East Africa; Nyasaland Protectorate; North-Eastern Rhodesia. Type of ♂ from North-Eastern Rhodesia, near mouth of Lusangazi River, 1–3. ix. 1910 (*S. A. Neave*); type of ♀ from Zungeru, Northern Nigeria, November, 1910 (*J. J. Simpson*); both specimens, as well as a series of para-types from various localities, presented to the British Museum (Natural History) by the Entomological Research Committee.

Within the last twelve months, some hundreds of specimens of this species, chiefly collected by Messrs. Simpson and Neave, have been received by the Entomological Research Committee from the countries mentioned. In Northern Nigeria, Mr. Simpson, who, like other collectors in the same colony, has hitherto only met with the female, took *Tabanus pertinens* in large numbers on the polo ground at Zungeru, in November, 1910; additional specimens, collected at the same time and place, were received by the Committee from Dr. J. W. Scott Macfie. Other Northern Nigerian localities at which the species was met with by Mr. Simpson are:—Kateri (2. xii. 1910), Kumbaku and Kogin Sirikin Pawa (6, 7. xii. 1910), the railway-crossing over the Kaduna River (10. xii. 1910), and Izon (15. xii. 1910). One specimen, taken on the Benue River in January, 1910, was received from Dr. C. E. S. Watson, W.A.M.S., and a female from Anka, Sokoto Province, 24. xii. 1910 (*Dr. J. McE. Dalziel, W.A.M.S.*), is in the possession of Dr. J. H. Ashworth, of Edinburgh University.

In the Anglo-Egyptian Sudan, three females of *T. pertinens* were taken at Kadowah, Mongalla Province, 21. i. 1911, by Mr. H. H. King.

The following is a brief summary of the specimens of this species collected by Mr. S. A. Neave:—

East Africa Protectorate: 1 ♂, 6 ♀♀, Voi, 1,800 ft., 21–23. iii. 1911; 1 ♀, Tsavo River, 24. iii. 1911.

German East Africa: 19 ♀♀, Baka River, on road from Nwaya to New Langenburg, 17. xi. 1910; 1 ♀, Usangu District, 26. xi. 1910, "at water hole"; 8 ♂♂, 30 ♀♀, Little Ruaha River, South Usangu District, 3,500 ft., 28. xi. 1910.

Nyasaland Protectorate: 2 ♂♂, east of Mvera, 3,500 ft., 10, 11. x. 1910; 9 ♂♂, 1 ♀, Lower Lintipe River, 12, 13. x. 1910; 1 ♀, Lingadzi River, near Domira Bay, west shore of Lake Nyasa, October, 1910.

North-Eastern Rhodesia: 26 ♂♂, 150 ♀♀, chiefly from Hargreaves and the vicinity, September, 1910.

Tabanus pertinens, which is not especially closely allied to any of its congeners at present known, as regards the width and shape of the front, is not unlike *T. sufis*, Jaenn., which also occurs on both sides of the continent. Apart from all other characters, however, the female of the new species may be distinguished from that of *T. sufis* by the fact that the most conspicuous markings on the dorsum of its abdomen do not consist of a double longitudinal series of light-grey *oblique* spots on a slate-black ground, as well as by the absence of an appendix to and infuscation on the base of the anterior branch of the third longitudinal vein.

According to Mr. Simpson *Tabanus pertinens* is troublesome to human beings, whom the females attack with almost the pertinacity of a *Haematopota*.

NOTES ON THE PRELIMINARY STAGES OF GLOSSINA MORSITANS, WESTW.

By Allan Kinghorn, M.B., Toronto.

(*Luangwa Sleeping Sickness Commission, Administration of Northern Rhodesia.*)

Seeing that *Glossina morsitans*, the typical "tsetse" fly of writers on South Africa, has been well known for perhaps a longer period than any other member of the genus, it is a matter for great surprise that much of its life history is yet entirely unknown. A large mass of literature, dealing with its general habits, is extant, but the breeding habits and the larva have not been described. It is noteworthy that only last year a single specimen of the puparium was discovered for the first time,* and when the wide distribution, the great plentitude, and the economic importance of the fly are considered, this becomes all the more remarkable.

The notes given below have been compiled while breeding *Glossina morsitans* in the laboratory for the purpose of making experiments on the transmission of trypanosomes, and deal more particularly with the breeding habits, the larva, and the pupa. The observations have extended over a very short period, from the middle of June to the middle of August, and are, therefore, rather incomplete, but it is hoped that when more time has elapsed it will be possible to elaborate them, and to correct any errors which may have arisen.

The months in question lie at the height of the dry season in this country (Northern Rhodesia), and the meteorological conditions have been as follows (temperatures given in degrees Fahrenheit).

	External Shade Temperatures.			Relative humidity.	Rainfall.
	Maximum.	Minimum.	Mean.		
June	83·2	51·3	67·2	48·6%	0
June	84·7	52·7	68·7	45·7%	0
August (1st to 20th)	89·4	54·0	71·7	37·4%	0

Laboratory Temperatures.

	Maximum.	Minimum.	Mean.
July	76·4	58·5	67·4
August	77·8	64·6	71·2

* Austen, E. E., A Handbook of the Tsetse Flies, London, 1911.

Temperature and humidity are factors which have been found to have an influence both on the breeding habits, and on the duration of the pupal period, in other species of *Glossina*, and it is quite probable that they would have a similar effect in the case of *G. morsitans*. Such information, however, is lacking at present.

In this paper the general bionomics are not dealt with, but it may be mentioned, in connection with the food of this fly, that oval nucleated blood-cells were found in the gut of one, amongst a number of freshly-caught flies which were dissected.

Technique.

The method observed in preserving and feeding the captive flies was essentially that described by Kleine.*

Freshly-caught flies, two females and one male, were placed in wide-mouthed glass tubes, measuring 5 by 2 inches, and the mouth was then closed over with mosquito-netting held on by an elastic band. The flies were fed daily on native fowls during the warmer hours of the day, when they readily gorged themselves. Roubaud† has recorded, in the case of *Glossina palpalis*, that the females do not feed as often as the males, but this has not been found to be so with *G. morsitans*. Both sexes have fed with equal avidity. After the completed meal, the insects were changed into clean, unlined tubes, and under these conditions it has been possible to keep some of them alive for over two months, at the time of writing, and to obtain larvae.

When first introduced into the tubes, the flies are very active, making wild efforts to escape, but in a very short time they become habituated to their new surroundings and remain quiescent. The males have been found to die much sooner than the females, and this may possibly indicate that the natural duration of their life is shorter.

Many of the female flies, when first caught, were observed to contain larvae in various stages of development, so that the period which elapsed from the time of capture to that of the first birth varied from four days to over a month. It would appear from this, as in the case of *G. palpalis*,† and *G. brevipalpis*,‡ that the production of larvae proceeds throughout the dry season.

Breeding Habits.

Copulation was frequently observed between the captive flies, more often after feeding. During this process the mates are firmly locked together, and refuse to separate even on violent shaking of the tube. It continues for several hours, as a rule, and on a few occasions, two flies which coupled in the afternoon were found the following morning still fastened together. Coupling may occur more than once between the same two flies.

* Abstracted in Bulletin of Sleeping Sickness Bureau, Vol. iii., No. 26.

† Roubaud, La Maladie du Sommeil au Congo Français, Paris, 1909.

‡ Stuhlmann, "Beiträge zur Kenntniss der Tsetsefliegen," Arb. a. d. Kaiser. Gesundheitsamte, Band xxvi, Heft 3, pp. 301–383.

Considerable irregularity has been displayed by the females in extruding larvae. After the first one had been born, many of them did not produce a second for a considerable length of time, and this may have been dependent upon the meteorological conditions to some extent. A number of the flies, however, have produced a second larva at an interval of from 14 to 15 days after the birth of the first, and this may be taken to represent the normal period of gestation under the laboratory conditions.

At the completion of its intra-uterine life, the larva almost completely fills the abdomen of the mother, and can be made out through the parietes as a dull yellowish-white oval body, with the black tumid lips presenting. These become a prominent feature several days before birth. The extrusion of the larva is accomplished very rapidly, and the maggot commences to crawl about as soon as it is born.

The only accident of gestation which has been seen is the abortion of various-sized larvae, and most of these mishaps occurred during two or three cold, cloudy days. Intra-uterine pupation, mentioned by Roubaud, has never been noticed.

The Larva.

The larva of *Glossina morsitans* resembles those of other species of the genus which have been described.

Fig. 1.—Dorsal view of larva of *Glossina morsitans*, Westw., showing the tumid lips and antennae. × 10.

It is a small, elongated maggot, characterised by the black tumid lips which spring from the last segment. The body is composed of twelve segments, and is widest and thickest at the junction of the posterior and middle thirds, whence it tapers more noticeably towards the pointed anterior end. The tumid lips are placed slightly dorsally and rather obliquely to the long axis of the body, so that they are directed backwards and upwards as the larva moves about. In colour it is a dull yellowish-white with a slightly dusky tinge, which becomes more

pronounced during the wave-like contractions of the body. When examined under a pocket lens, the integument is seen to be very finely mammillated, and these mammillae have a dark tint, which imparts the general appearance of duskiness mentioned above.

From the first segment two minute black bristles, about 0·5 mm. in length, project. These are parallel to one another and are situated laterally on either side of the middle line. On magnification they are seen to be club-shaped, and are the representatives of the antennae. Between them lies the mouth, the lips of which are directed dorso-ventrally, and are blackish in colour. A trachea can be traced, on either side, as a retractile tube extending from the base of the tumid lips to about the central portion of the body, while on the mid-ventral line, at the junction of the eleventh and twelfth segments, the anus is represented by a small, round, black spot.

The tumid lips are characterised by a row of short longitudinal striations along the basal portion, from which spring two knob-like prominences, rounded externally, and separated by a comparatively deep sulcus. Internally they are hollowed out to form a small cavity, on either side of which lies one of the spiracles. The prominences are beset with small tubercles, and are marked off into three more or less equal portions by two shallow furrows. In colour the tumid lips are jet-black. In his description of the pupa, Austen states that the sulcus between the two knobs of the tumid lips does not show the key-hole shape found in that of *Glossina palpalis*, but in many of our pupae, however, there is a suggestion of such an outline, as will be noticed in fig 2.

The behaviour of the larva differs somewhat with its surroundings. If left in a glass dish it may crawl around for from one to two hours, but sooner or later, becomes stationary, retracts its head, assumes the oval puparial form and proceeds to pupate. The movements are worm-like, the contractions passing along the body in waves. From time to time, the larva ceases to progress, and after retracting the anterior end slightly, moves its head from side to side, and up and down, as though trying to push aside some obstacle. The reason for this becomes apparent as soon as it is placed on dry, powdered earth. In this situation the larva at once commences to burrow down and is lost to sight in a minute or two. When it has gone from one to two centimetres, it becomes quiet, and proceeds to pupate as before. During this process the skin darkens gradually, and at the same time hardens to form the pupa-case. These changes are usually completed in from four to five hours.

Apparently the larva is capable of secreting a slightly viscid fluid, for in glass tubes they often adhere to the sides. When this has occurred, pupation soon follows. The purpose of this fluid may perhaps be to gather the earth around the pupa, and may possibly account for its not having been found earlier.

The Puparium.

In shape the puparium is more or less regularly ovoid, and varies in colour from a dark reddish-brown to a dull matt brownish-black, contrasting with the jet-black of the tumid lips. The pupa-case shows the mammillations mentioned in the description of the larva.

The means of the measurements of twenty pupae are as follows, in millimetres, the extremes being given in brackets:—total length, 5·53 (5 to 6); width, 3·2 (3 to 3·75); depth, 2·97 (2·75 to 3·25); width across tumid lips, 1·45 (1 to 1·5). It will be seen from these data that the pupa is slightly compressed in the dorso-ventral diameter.

Fig. 2.—Dorsal view of the puparium of *Glossina morsitans*, Westw. × 10.

Fig. 3.—Puparium of *Glossina morsitans*; A, anterior view, showing lines of dehiscence; B, ventral view of posterior portion, showing anus enclosed in eye-shaped area. × 10

The larval mouth is represented on the first segment of the pupa as a small black dot, while the anus is similarly marked on the mid-ventral line at the junction of the eleventh and twelfth segments, and is enclosed in a small eye-shaped area marked off by two small furrows, the anterior of which is formed by the dividing line between the two segments (fig. 3, B).

The line along which the pupa-case splits to permit of the emergence of the imago, is indicated on the anterior portion of the puparium as a small ridge directed laterally. This ridge passes dorsally around the mouth region as a slight curve, and is shown in fig. 3, A.

Duration of the Pupal Stage.

Owing to pressure of other work, it has been impossible to determine the effect of temperature and humidity on the length of the pupal period. The pupae, as they were obtained, were placed in glass tubes and left exposed to the laboratory air without any protection. In these circumstances the time which has elapsed from the birth of the larva to the escape of the imago has varied from 47 to 53 days.

In conclusion, I should like to express my indebtedness to Mr. Ll. Lloyd, the Entomologist of this Commission, for suggestions, and for the accompanying drawings.

Nawalia, N.E. Rhodesia,
August 21, 1911.

COLOUR CONVENTIONS TO INDICATE THE DISTRIBUTION OF BLOOD-SUCKING INSECTS AND THE DISEASES THEY TRANSMIT.

By Jas. J. Simpson, M.A., D.Sc.

(Plate VI.)

The necessity for graphic representation of the distribution of insects and the diseases which are transmitted by them is now so evident as to need no special demonstration. But it is further obviously important that some uniform method should be adopted in the preparation of such maps, in order to make them inter-comparable, and the object of the present notes is to suggest a comprehensive system of notation for the whole genus *Glossina*—a system which may be readily adapted for use in other genera or families of blood-sucking insects.

The only scheme hitherto adopted was that used in the maps published by the Sleeping Sickness Bureau in which red was restricted to sleeping sickness, brown to *Glossina tachinoides*, blue to *Glossina palpalis*, green to *Glossina morsitans* and *G. pallidipes*, and yellow to *Glossina fusca*. At the time when that scheme was formulated the recognised species of *Glossina* were much fewer than at present and their bionomics were less perfectly known. Further, the records of *Glossina morsitans* and *G. pallidipes* were not sufficiently exact to permit of discrimination between the two species and one colour had consequently to be used to include both.

Recent work has shown more emphatically than ever that such distinctions are not only advisable, but necessary, and this, combined with the fact that several new species have recently been described, renders it impossible to assign to each of the species a definite colour sufficiently distinctive to avoid confusion. This will be at once evident when it is remembered that there are, at present, seventeen species of *Glossina* more or less universally recognised. Some of them are, however, subjects of controversy, but until such disputes are definitely settled we must take note of them separately. Moreover, in the event of any so-called species being either submerged or proved to be distinct, it will be much easier, and lead to less confusion, to group two series of conventions, already published, into one, than to divide one series into two or more. In fact, the latter procedure is possible only after a re-examination of all the specimens so recorded—an almost impossible task.

So far, only sleeping sickness and *Glossina* have been considered, but it may be found advisable also to record graphically other diseases and their carriers, for example, yellow fever and *Stegomyia fasciata*. For the present it is proposed to deal only with the former, but it will be evident that should maps be required for the latter a similar system of notation could be employed.

If we recognise, therefore, the necessity for representing graphically the distribution of sleeping sickness and of seventeen species of *Glossina* and the

futility of assigning to each a colour or shade which will be sufficiently distinctive, the most satisfactory solution will be to adopt a few distinct colours for groups and variations in the shape of the symbol for individual species.

The following scheme has been drawn up on this basis and has been used in the maps accompanying my reports. I may also say that in the preparation of the scheme I have consulted Dr. A. G. Bagshawe, the Editor of the Bulletin of the Sleeping Sickness Bureau, and also Mr. Guy A. K. Marshall, the Editor of this Bulletin, and that the system will be adopted in any further maps which may be published in colour in either of these Journals.

Symbols.—To achieve their aim these ought not to be excessive in number and should be sufficiently distinctive to be easily recognisable from one another at a glance. After a series of trials the following have been considered most satisfactory :—(1) a solid circle, (2) a solid square, (3) a circle enclosing a cross, (4) a square enclosing a cross, (5) a solid triangle, (6) a hollow triangle, (7) a hollow circle, and (8) a hollow square. Modifications of these could easily be multiplied (*see* Plate VI). In the present system it is not necessary to adopt any more, as only in one group, namely the *palpalis*-group of *Glossina*, in which there are six species, do we require more than four symbols.

Colours.—Red has already been assigned to sleeping sickness, and it seems most advisable to retain its use for this disease. By means of the symbols already given it is easily possible to represent other diseases, if necessary, by the same colour.

In the case of *Glossina* some sort of grouping is necessary, and separate colours should be adopted for these groups. Mr. E. E. Austen in his recent work* on this genus divides the various species into four groups, and although there may be a difference of opinion as to the relative values of these from a taxonomic point of view, the arrangement forms a good basis for the purpose in hand and obviates the necessity of introducing too large a number of symbols. Consequently I have adopted it in this system and have added the various controversial and new species since described in their respective groups,

The following colours have been selected after a series of tests as being sufficiently distinct to avoid unnecessary confusion and have been assigned to the various groups as follows :—

palpalis-group—blue ;
morsitans-group—green ;
fusca-group—brown ;
brevipalpis-group—orange.†

It is unnecessary here to enter into the details of the various species as I have already explained the different symbols used and the application of these can easily be seen at a glance on the accompanying plate.

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* A Handbook of the Tsetse-Flies, 1911, pp. 19, 20.

† Yellow has been purposely avoided as it is never very distinct, while in artificial light it is hardly recognisable.

Although improbable, it is quite possible that further new species may be found, and to allow for this contingency I have added at the foot of the plate several symbols which could be used in the respective colours if necessary.

Further it must be noted that observers well acquainted with the genus *Glossina* but unaccustomed to differentiate the various species often record such under the general term "tsetse." These records obviously could not be included on maps which show only species in detail according to this scheme, but at the same time it is advisable to indicate them for the guidance of others who may visit the same locality and also to show the range of the genus. For these reasons I have added on the plate a symbol in black which could be used to indicate the presence of undetermined species of *Glossina*.

BULL. ENT. RESEARCH. VOL. II. PART 4.

Sleeping Sickness.

GLOSSINA

palpalis-group.

- *palpalis.*
- *tachinoides.*
- *caliginea.*
- *pallicera.*
- *fuscipes.*
- *maculata.*

morsitans-group.

- *morsitans.*
- *longipalpis.*
- *submorsitans.*
- *pallidipes.*

fusca-group.

- *fusca.*
- *tabaniformis.*
- *nigrofusca.*
- *fuscipleuris.*

brevipalpis-group

- *brevipalpis.*
- *longipennis.*
- *medicorum.*

Undetermined species.

Symbols for addutional species

COLOUR CONVENTIONS FOR INSECTS AND DISEASE

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ENTOMOLOGICAL RESEARCH IN BRITISH WEST AFRICA.

II. NORTHERN NIGERIA.

By Jas. J. Simpson, M.A., D.Sc.

(*With a Map showing the distribution of* Glossina *and sleeping sickness, two sketch maps and* 16 *photographs by the author.*)

(Plates VII.—XVI.)

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Introductory.

The following report on recent entomological investigations in Northern Nigeria is based on a short tour made by the writer, from the 11th of August, 1910, to the 21st of January, 1911. But incorporated with my own observations

are numerous records made by several medical officers and other officials in the Protectorate. The present work deals exclusively with the blood-sucking insects and other arthropods which are, or may be, implicated in the transmission of disease in West Africa, and is therefore an extension of my previous report on the same subject in relation to the Gambia.*

Prior to the formation of the Entomological Research Committee, through whom this work is being conducted, very few specimens of insects and only a few isolated records reached England from the various Tropical African Colonies: but since that time numerous officials, and not the least in Northern Nigeria, have made systematic surveys of the districts in which they are stationed, and our knowledge of the distribution of the various species, their habits, and habitats is now gradually increasing. Only by this means can it ever be hoped to formulate any definite schemes for the abatement of the various diseases which may be transmitted by these insects.

The thanks of the Committee are due to those who have aided in this work, but it is unnecessary to enter into the various details here, as the collections have been identified and lists sent (along with named specimens where desired) to the individual collectors, and receipt has been acknowledged from time to time in the various issues of this Bulletin. In case it may not be universally known, I might take this opportunity of pointing out to any officials or others, who may be interested in this work, but who have no means of identifying the insects collected, that any collections sent to the Entomological Research Committee will be identified and recorded, and, if requested, named specimens will be returned to the collector, along with any available information which may be desired. It is hoped, therefore, that many will take this opportunity of familiarising themselves with the various noxious insects in the Protectorate, and at the same time help to extend our knowledge of their life-histories and distribution.

An account of the more simple methods of collecting and preserving insects for transmission to England was added as an appendix to my Gambian report, and separate copies of this may be obtained from the Scientific Secretary of the Committee by anyone desirous of aiding in this investigation.

The duration of my stay in the Protectorate, namely, five and a half months, precluded the possibility of my attempting to traverse anything but a limited portion, and for this reason I confined my attention to the River Niger, some of its tributaries, and the railway systems, as in those regions one would expect to find *Glossina palpalis* most universally distributed. At the request of Dr. S. W. Thompstone, C.M.G., the Principal Medical Officer, I also made a fairly exhaustive inspection of the Kateri district (p. 330), the River Garara (p. 335), and the Province of Bassa (p. 339), in all of which sleeping sickness was reported to occur. Consequently, this report deals mainly with the south-west portion of the Protectorate, or, in other words, the Niger basin, and is concerned very little with the Benue or Chad systems. For this reason it must be pointed out that

* Bull. Ent. Res. II, pt. 2, pp. 187–226.

it does not in any way aim at being exhaustive, but by showing how scanty our knowledge of this subject is, it may stimulate others to collect and make observations on the various species of insects which are harmful or beneficial to man and animals.

For a proper understanding of the distribution of not only tsetse but also other insects, several general considerations have to be taken into account; for example, the geographical position of the Protectorate, the general topography, the river systems, the nature and extent of the various types of vegetation, the climate and the rainfall. Each of these has been discussed in a very general way, only in so far as they are likely to influence the problems with which we are here more intimately concerned.

A short section has also been added on the chief tribes inhabiting the Protectorate, as, to a great extent, their distribution and mode of life have often a direct bearing upon the dissemination of disease.

Several photographs (Pl. viii.–xv.) and two sketch maps (Pl. vii. and xvi.) have also been included to illustrate some of the points emphasised in the report. The former serve to show the various types of country either associated with or free from certain species of *Glossina*. The first sketch map illustrates the general contour lines and river systems, while the second has been added as the region it depicts is uncharted on the larger map.

The most recent map (scale 1·014 inches=32 miles) of the Protectorate has been reproduced to show the distribution of the various species of *Glossina* which occur there, and in it have been inserted all available authentic records, including those in the National Collection in the Natural History Museum. In another paper in this Bulletin,* I have discussed the question of the graphic representation of the distribution of insects and disease on maps, and have suggested a scheme which has been adopted in the compilation of the present map, and which will be used in all maps published in colour in this Bulletin, and also in that of the Sleeping Sickness Bureau.

The various sections in the Narrative do not follow the order in which the different parts were traversed by the author, but are arranged so as to form a more or less complete unit, and the whole route is shown on the accompanying map.

A list of the blood-sucking insects and ticks hitherto recorded from Northern Nigeria has been drawn up as a guide to those interested in this work, and notwithstanding the fact that the number of species is already large, there is little doubt that many new species will be found to occur, chiefly in the northern part of the Protectorate.

I. Geography of the Protectorate.

(*a*.) Position and Extent.

The Protectorate of Northern Nigeria, the largest and most recently acquired of the British West African Possessions, is roughly rectangular in shape, and

* Bull. Ent. Res. II, pt. 4, pp. 297–299.

lies approximately within the parallels of 7° and 14° North latitude, and between the meridians of 3° and 15° East longitude. It is bounded on the north by the arid regions of the French Sudan, on the west by the lofty Kamerums, on the east by the French Colony of Dahomey (or French Nigeria), and on the south by Southern Nigeria. Commercially, its position is excellent, inasmuch as it enjoys all the advantages of magnificent waterways. Its area is approximately 255,700 square miles of which the greater part lies in and north of the obtuse angle formed by the two main waterways, the Niger and the Benue. In the north-east corner is that perplexing inland sea, Lake Chad ; while the north and north-west portions practically adjoin the southern limits of the Sahara. These fundamental features must be borne in mind in connection with much of the entomological matter which follows.

The headquarters of the Protectorate are situated at Zungeru, which is now joined by railway with Lagos, the capital and main seaport of Southern Nigeria, and also with Kano, an ancient and important city in the extreme north. It is, however, more a political than a commercial centre.

Lokoja, situated as it is at the junction of the Benue and Niger, must always remain an important commercial and geographical centre, though of recent years, owing to the extension of the railway from Lagos to Zungeru and the north, it is somewhat less important than formerly. All heavy transport must pass up the Niger, and the only inlet and outlet for the Southern Provinces, Kabba and Bassa, as well as for the Baro-Kano Railway and the whole Benue system, Muri, Yola, and Bornu, must therefore culminate at Lokoja, which consequently, as at present, must remain the headquarters of the river traffic and a main commercial centre of Northern Nigeria.

The Baro-Kano Railway, as the name implies, joins the towns of Baro, on the Niger near the mouth of the Bako River, and Kano near the desert region of the north, by way of Minna, where it joins the Northern Nigerian extension of the Lagos Railway. Consequently, Baro must, as trade extends, become an important commercial centre, as it is the extreme limit to which ocean-going steamers can ascend at the season of high water in the Niger.

Therefore Zungeru, as the headquarters of the Protectorate ; Lokoja, as the commercial and river centre for the Southern provinces and those of the Benue system ; and Baro, as the last port-of-call for ocean-going steamers and the terminus of the Baro-Kano Railway, must always be the chief centres of European activity, and, as such, must be the primary foci to which attention should be directed in preventing the dissemination of disease. If at any time any of these places should become sleeping sickness centres (as seemed likely recently in the case of Baro), the infection might spread to Europeans with disastrous results. As much, however, has already been done to prevent this, and as each locality will be considered in detail later on, it is unnecessary to enter further into this question here beyond pointing out that geographical and topographical position must be considered in the selection of sites for towns, and in the choice of routes, railway or otherwise, in opening up new country. These

points will, therefore, be kept prominently in view in this report when the writer is considering in detail the various regions visited.

(*b.*) Mountain and River Systems.

A sketch map (Pl. VII) has been added to illustrate the general contour and the river systems in the Protectorate, so that it is necessary here to draw attention only to the major features. The dotted contour lines indicate the average level of the various regions in the country, and from these it will at once be seen that the general altitude is not great.

The Bauchi plateau, the highest part of the Protectorate, is only between 4,000 and 5,000 feet above sea-level, and forms the central watershed of the Protectorate, whereas Lokoja, 337 miles, and Jebba, over 600 miles from the sea, are respectively only 300 and 500 feet above sea-level; so that the general fall of the river is only about one foot per mile.

There are two main river systems in Northern Nigeria; first the inland system which drains into Lake Chad in the north-east corner; and second, the Niger-Benue system, with its outlet to the sea through Southern Nigeria.

(1) Lake Chad is a lake only in name, and consists of nothing but an immense marsh with variable stretches of open water nowhere more than twelve feet deep.

The basin of Lake Chad lies curiously between the watersheds of the Niger and the Nile, and is supposed to be the remains of a vast shallow inland sea which covered most of the region north-east and west of the present lake, and which probably communicated with the sea along the basin of the Senegal River. A recent French expedition has shown that, at any rate in the rainy season of one particular year, there was a continuous water connection between the Benue and Lake Chad through the Tuburi marshes into the Logun river, and thus into the Shari river, which runs into the Lake. This being so, the lake was *then* nothing but a backwater of a river system in Central Africa, which sent a superfluity of its waters to the Benue and the Niger.

But, apart from this, Lake Chad merits attention here from the fact that it drains roughly one quarter of the Protectorate of Northern Nigeria (the north-east portion), and, as will be seen later, is of great interest in connection with the distribution of the various species of *Glossina*.

(2) The Niger-Benue system drains the rest of the Protectorate—the Benue the south-eastern quarter, and the Niger the western half.

There are two primary watersheds in the Protectorate itself, and these radiate from the Bauchi Plateau, the first north-west, and then north-east to the French Sudan near Katsena, the other north-east and then south-east to the Kamerun

mountains; within the angle thus formed lies the Lake Chad system. These watersheds are indicated on the map.

West of the first lies the Niger system, which has its westerly and southerly limits in another watershed which practically forms the boundary between Northern and Southern Nigeria along the Borgu, Ilorin and Kabba frontiers, and separates it from the smaller rivers, such as the Ogun in Southern Nigeria.

South of the second watershed lies the Benue system, which is bounded on the south by a spur of the Kameruns; this spur abuts into Southern Nigeria in the newly opened up Sonkwala country and separates the Benue from the Cross River, which flows through the Eastern Province of Southern Nigeria.

As has already been mentioned, the Bauchi Plateau, lying near the middle of the Protectorate, is the central watershed, and from it rivers radiate in all directions, but eventually join one or other of the two main systems already described.

The largest river running into Lake Chad is the Yo, which flows in a north-easterly direction and receives the waters of the Shidya, Delime, Katagum, and Hadeija Rivers, which flow from the Bauchi Plateau itself and the watershed running north from it, while from the watershed that passes eastwards come the Maiduguri and Yedseram Rivers. All the rivers running south from this last watershed drain into the Benue, which rises in the Kamerun mountains, and flows slightly south of east. The largest of these is the Gongola, which rises in the Bauchi Plateau, runs north-east and then south, and joins the Benue near Yola. From the south drain the Taraba, Katsena, etc. The Benue enters the Niger at Lokoja. Quite as erratic in its course as the Gongola is the Sokoto River, which rises near Katsena, flows north-west then south, and eventually joins the Kebbi, which in its turn enters the Niger near Illo. Other important tributaries of the Niger on the north bank are the Malenda, Kontagora, Kaduna, Bako and Garara, while on the south there are none of any great size.

Such, then, are the main physical features of the Protectorate, and a knowledge of the relative positions and directions assumed both by the watersheds and the various rivers serves to elucidate many interesting but otherwise obscure facts in insect distribution. This can most easily be understood by a study of the accompanying map.

(*c.*) Vegetation.

It is very difficult to describe in any general way the nature of the vegetation in Northern Nigeria, as there are no definite zones of afforestation, and the different types found are modified by local conditions.

Generally speaking, however, the monsoon forest type is predominant in the south; and in the north the thorn forest, though here the savannah forest or open

deciduous forest, and the pure savannah are also more or less in evidence. Wherever the dry season is short and there is a certain amount of rainfall practically throughout the whole year, the monsoon forest is met with; while, on the other hand, when the rainy season is extremely short and the dry season is accompanied by the hot dry wind from the Sahara, the predominant feature is long grass, and few if any trees or shrubs are to be seen. Consequently, according as the climatic conditions of any particular region are nearer one or other of these types, dense forest, open forest, or savannah will be found in excess. Further, the fierce fires which are so common during the dry season have a marked influence on the vegetation, inasmuch as they materially affect the woodland growth, but not the grass, so that where these fires are prevalent savannah forest approaching pure savannah is found.

Passing from the north to the south, we find an almost regular increase in the amount of non-deciduous arboreal growth, and a consequent decrease in deciduous low scrub and grass. On the other hand, the banks of the rivers and streams, where the soil is constantly moist, are covered with a dense forest growth, and this is also found in numerous places where there is permanent telluric moisture due to local physical conditions; many of these places, if judged by the amount of rainfall and the length of the dry season, would not appear suitable for such vegetation.

These local patches are found scattered all over the southern half of the Protectorate, but do not seem to extend into the savannah region of the north. They are known by the local name of "kurimi," and as this term will be frequently used in the narrative, a short description may not be out of place here. Occasionally, these are of very limited extent, but sometimes stretch in narrow belts of 50–200 yards in width for several miles. The soil is continually moist and covered with a thick layer of leaves and decaying humus. Large non-deciduous trees are abundant, and there is a dense undergrowth of thick scrub, the whole being bound together by thick, woody and succulent lianas (Pl. XIV, figs. 1 and 2). Grass and herbs are practically absent. The larger trees have frequently well developed buttresses, and others have strong aerial roots. Such belts are very difficult to penetrate, but when an entry has been made, the dense nature of the shade, the fall in the temperature, the humidity of the atmosphere, and the almost perfect stillness are points which at once strike the intruder. As these are practically always haunts of *Glossina palpalis*, the importance of a knowledge of their origin, extent and distribution becomes evident, but this will be referred to in greater detail in the narrative.

The savannah forest is what might be termed park-like in character, and is the predominant feature in the landscape in the centre and northern parts of the Protectorate. Grass is abundant, as also are low deciduous shrubs, while scattered throughout are trees, varying in number and size in the different parts. This type of country is more suitable for *G. tachinoides* and *G. submorsitans* than for *G. palpalis*, and a survey of such a region generally shows that where trees are abundant *G. tachinoides* is found, while where low shrubs and grass predominate *G. submorsitans* is more common.

In many places throughout the Protectorate, there are extensive swamps and marshes, which are almost invariably connected with a heavy clay soil. During the rainy season, these may be covered with water several feet deep, but at the height of the dry season, elephant grass, attaining a height of 8–14 feet, generally covers these "fadamas," as they are termed locally.

This, then, may serve to give a general idea of the main types of vegetation occurring in Northern Nigeria, and in this connection it might be well to remember that when any type of tropical vegetation is devastated, it is generally replaced by a drier form, and this again, if demolished, will give way to a type of vegetation unlike its predecessor, but always diminishing in density and consequent shade and surface moisture.

II. Climate and Rainfall.

Having discussed the general physical configuration of the Protectorate, we we may briefly review the main climatic conditions which obtain in the different regions, and so form a definite basis for a study of insect distribution. In this way many points, otherwise obscure, in connection with the limits of the various species of *Glossina* and other blood-sucking flies, will be more easily grasped, as there can be little doubt that the relative duration of the wet and dry seasons, the varying degrees of humidity, and the annual range of temperature have a distinct bearing on this subject.

No review of the meteorology of Northern Nigeria has been published, nor has any attempt been made to consider the extremes of climatic conditions to be found in the Protectorate. The following observations, therefore, are based on a study of the raw meteorological data compiled during recent years at the various stations, published in the official Gazette, and supplied to the Meteorological Office. In order to avoid a lengthy discussion on this subject, several tables have been prepared, so that a glance at these will bring out in a more concrete form much of what follows.

Northern Nigeria, as has already been pointed out, lies roughly between the 7th and the 14th parallels, and the climate is therefore tropical but not equatorial. By this is meant that in contrast, for example, with Southern Nigeria, the rainfall and temperature curves show only one annual maximum and minimum. In the latter colony, except in the north-west corner, which is geographically in Northern Nigeria, the temperature curve reaches its highest maximum in March and April, after which it descends, but again reaches a secondary maximum in September and October. The curve of rainfall shows similar maxima and minima.

The prevailing wind in Northern Nigeria is the Harmattan, a dry hot wind coming from the north-east. It blows almost steadily from October to March, and modifies the temperature to an extraordinary degree. Coming direct from the Sahara, it is absolutely devoid of moisture, and consequently produces great evaporation when it meets the moist air of the Niger Valley or the inland system

of Lake Chad. The result during these months is an enormous fall of temperature, and in the extreme north, when the wind, without having absorbed any previous moisture, meets the mists and vapours of the water systems of the Northern Territories, the temperature occasionally falls nearly to freezing point.

Towards the end of the dry season, which varies in the different latitudes, the the tornados begin. These are cyclones from the north-east, accompanied by thunder-storms and torrential rains. They gradually merge into steady rains which last from July to October. During the rainy season, the atmosphere is laden with moisture, and a damp heat results, but for the rest of the year the Harmattan and a total absence of rain render the air excessively dry. Generally speaking, the nights are cool for the greater part of the year.

Owing, however, to the enormous contrast in the various climatic conditions in different regions of the Protectorate, it is impossible to make any satisfactory generalisations. Take, for example, the case of Geidam and Ankpa in 1909. At the former station, the maximum and minimum temperatures recorded were 110° Fahr. and 46° Fahr., while at the latter they were respectively 96° Fahr. and 56° Fahr. At Geidam, the total rainfall for the year was only 21·28 inches, while at Ankpa it was 66·85 inches; at the former the rainy season was practically confined to the months of May to September, but at the latter it extended from March to October. At Geidam, the maximum and minimum degrees of humidity were respectively 81 and 24 with a difference of 57, while at Ankpa they were 85 and 68 showing a difference of only 17. At the former, only during the month of August was there over 5 inches of rain (7·70 inches), while at the latter the following are the records—April 8·63 inches, May 14·02 inches, June 7·72 inches, August 8·12 inches, September 10·23 inches, October 8·80 inches.

With such an enormous difference in the climatic conditions in various parts of the Protectorate, it is not surprising to find that not only do certain species of blood-sucking flies show distinct local modifications, but there may even be a marked difference in the species which occur in the different districts.

In order to see to what extent these are correlated, the following tables have been drawn up :—

Table A :—The annual rainfall for various stations for the years 1906–1910.

Table B :—The monthly rainfall for the same stations for the years 1909 and 1910.

Table C :—The maximum and minimum humidity at these stations from 1906 to 1910.

Table D :—The monthly temperatures for the same stations for the year 1909.

As these tables show graphically the main factors with which we are here concerned, I do not propose to deal with each at any length, but only to draw attention to the major features.

TABLE A.

Annual Rainfall in Northern Nigeria (in inches).

	Katagum.	Maiduguri.	Sokoto.	Kano.	Yola.	Bauchi.	Lokoja.	Baro.	Kontagora.	Zungeru.	Zaria.	Ilorin.	Ankpa.
1906					34·60		51·83			60·39	61·05	49·00	
1907		18·11	19·86	25·62	27·55		36·68		37·28	37·16		54·74	
1908	23·70	22·30	20·44	34·86	53·77	47·88	44·12	46·46	55·15	48·78	45·48	55·46	58·77
1909	23·03	31·89	29·72	49·03	41·26	43·23	65·14	55·77	60·67	58·89	55·80	65·18	66·85
1910	18·21	19·53	23·11	26·81	38·67	38·86	45·49	47·98	53·01	53·44	53·80	51·14	56·44
Mean	21·65	22·96	23·28	34·08	39·77	43·32	48·65	50·07	51·53	51·73	54·03	55·10	60·69

The above table reveals several important facts, but none more obvious than the striking difference in the rainfall at the various stations. The maximum rainfall recorded during these five years is 66·85 inches, at Ankpa in 1909, and the minimum is 16·87 inches, at Geidam* in 1910, while the difference between the rainfall at Geidam and Ankpa in 1909 amounts to 45·57 inches, or more than twice the total rainfall at the former station.

A study of the mean annual rainfall at the various stations shows that there is an almost regular increase from the north southwards. At one end of the scale stand Sokoto, Katagum, Maiduguri and Geidam, in the extreme north, and at the other Ilorin and Ankpa in the south.

TABLE B.

Monthly Record of Rainfall in Inches for 1909 *and* 1910.

1909.

STATION.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Geidam ...	—	—	—	1·05	1·42	4·39	4·79	7·70	1·83	0·08	—	0·02
Katagum ...	—	—	—	0·11	3·98	4·05	4·02	6·32	4·17	0·33	—	0·05
Birnin Kebbi	—	—	—	2·92	3·31	3·35	2·37	12·98	2·34	0·43	—	—
Sokoto ...	—	—	—	1·55	1·52	4·34	8·72	10·61	2·52	0·40	—	—
Maiduguri ...	—	—	—	1·01	0·75	4·04	5·33	12·06	8·66	0·04	—	—
Nafada ...	—	—	—	3·59	1·29	5·12	8·66	10·82	6·89	0·90	—	—
Bauchi ...	—	—	—	3·99	2·53	5·64	10·76	11·16	8·73	0·42	—	—
Yola	—	—	0·35	4·33	3·90	10·13	6·23	7·56	8·23	3·35	—	0·18
Keffi	—	1·13	3·12	3·39	4·94	6·52	9·10	14·14	4·48	2·20	—	—
Kano ...	—	—	0·09	1·75	8·70	3·71	9·01	17·72	6·83	0·77	—	0·45
Ibi	—	0·70	2·75	6·40	8·48	5·23	5·01	7·57	8·89	7·49	—	0·78
Baro	1·06	0·80	3·00	6·74	3·49	6·73	8·19	16·92	6·60	1·88	—	0·36
Zaria	—	0·36	—	3·56	5·79	6·51	13·11	16·62	6·61	1·74	—	1·50
Zungeru ...	0·38	—	2·02	4·66	3·27	6·09	12·88	11·24	14·27	2·78	—	1·30
Kontagora ...	—	—	2·51	6·42	2·02	6·22	13·33	13·12	12·87	3·83	—	0·35
Lokoja ...	0·04	1·32	5·19	6·80	8·20	6·90	10·35	12·13	10·37	2·61	—	1·23
Ilorin ...	0·79	1·18	5·30	7·78	7·12	8·32	9·49	4·92	14·12	4·74	0·23	1·19
Ankpa ...	0·39	—	3·64	8·63	14·02	7·72	4·42	8·12	10·23	8·80	—	0·88

* As the records for Geidam are available only for 1909 and 1910, it has been omitted from Table A, but is included in Table B.

1910.

Geidam ...	—	—	—	0·11	—	0·51	5·95	7·07	3·23	—	—	—
Katagum ...	—	—	—	0·25	1·49	0·95	5·02	7·45	3·05	—	—	—
Maiduguri ...	—	—	—	—	2·80	0·65	6·64	6·44	3·00	—	—	—
Sokoto ...	—	—	—	—	3·54	3·91	6·51	6·03	3·06	0·06	—	—
Birnin Kebbi	—	—	—	0·22	2·32	1·91	7·78	4·60	8·21	0·06	—	—
Kano... ...	—	—	—	0·02	0·98	4·12	8·10	8·97	4·62	—	—	—
Nafada ...	—	—	—	0·43	2·52	4·73	8·89	13·04	3·53	0·10	—	—
Yola	—	—	—	2·36	6·97	10·19	5·21	8·06	4·08	1·80	—	—
Bauchi ...	—	—	—	0·98	3·30	4·73	12·14	8·98	7·58	1·15	—	—
Keffi	—	—	1·04	1·72	5·30	5·28	4·71	13·98	9·30	3·10	—	—
Lokoja ...	—	1·03	0·26	4·45	5·67	8·07	10·66	5·98	5·76	3·61	—	—
Baro	—	—	0·15	2·35	5·00	4·69	15·20	12·23	4·15	3·21	—	—
Ibi	—	—	0·02	4·39	8·83	5·56	5·35	11·24	7·57	6·67	—	—
Ilorin ...	—	0·03	1·18	4·88	5·97	7·37	6·60	6·53	14·71	3·87	—	—
Kontagora ...	—	—	1·12	0·44	4·06	4·17	13·29	16·91	10·93	2·09	—	—
Zungeru ...	—	—	0·83	1·15	6·69	5·54	7·09	19·27	10·82	2·05	—	—
Zaria ...	—	—	—	2·17	3·78	4·95	11·28	17·73	13·08	0·81	—	—
Ankpa ...	1·34	—	1·02	5·65	10·04	5·64	9·38	11·42	5·60	6·31	—	0·04

In Table B is given the monthly rainfall for eighteen stations for the years 1909 and 1910, and as these stations are scattered over the territory, it is possible to compare not only the extremes, but also the intervening portions of the country. The arrangement adopted is that of ascending annual maxima.

It will be seen from Table A that, although there was a great difference in the amount of rain which fell during these two years, the total for each station bears roughly the same proportion to the total for the colony. The curve of rainfall has only one maximum, and that occurs in July and August, which months are therefore the centre of the rainy season. A rainfall of one inch or under is practically negligible, so that, with very few exceptions (which will be referred to later), November, December, January and February constitute the height of the dry season.

Although July and August on one side, and December and January on the other, are the centres of the wet and dry seasons respectively, the duration of these seasons varies very markedly in different regions; *e.g.*, at Geidam, in 1910, the dry season might be said to extend from October to June, while in the same year at Ankpa the dry season can be reckoned only from November to March.

It will be seen from the tables that, in spite of the difference in the rainfall in 1909 and 1910, the stations are arranged in certain well-defined groups, *e.g.*, (1) Geidam, Katagum, Birnin-Kebbi, Sokoto and Maiduguri; (2) Nafada, Bauchi, Yola, Keffi and Kano; (3) Ibi and Baro; (4) Zaria, Zungeru and Kontagora; (5) Lokoja, Ilorin and Ankpa; and that these groups of ascending rainfall are disposed in order from north to south.

In the northern stations, the dry season reaches its maximum, and may be said to extend from October to April, but at the same time, the monthly rainfall is never very great. The length of the dry season diminishes in the various groups, until (5) is reached; for example, at Ilorin, in 1909, rain fell during every month, and at Ankpa, in both 1909 and 1910, the only months in which there

was no rain were November and February. At the same time, the monthly rainfall is also greater in the south than in the north.

The maximum rainfall for one day for the years 1905–1908 was as follows: In 1905, 4·04 inches at Ilorin on June 2nd; in 1906, 7·27 inches at Zungeru; in 1907, 4·15 inches at Ilorin on September 9th; and in 1908, 5 inches at Ilorin in October.

Consequently no definite periods can be given for the wet and dry seasons in Northern Nigeria, but in a general way it may be said that the duration of the dry season decreases, whereas the amount of the monthly rainfall increases from the north to the south.

Table C.

Maximum and Minimum Humidity.

	1906.		1907.		1908.		1909.		1910.	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Geidam	—	—	—	—	26	81	24	81	29	83
Bauchi	22	73	—	—	—	—	26	82	26	77
Kano	—	—	28	81	—	—	27	83	28	75
Sokoto	—	—	22	86	—	—	27	76	25	72
Nafada	—	—	—	—	—	—	29	81	33	84
Katagum	—	—	—	—	26	86	30	76	28	70
Zaria...	32	80	—	—	32	80	31	79	33	86
Kontagora	24	85	30	90	—	—	32	80	27	84
Maiduguri	—	—	25	84	—	—	34	86	34	79
Birnin Kebbi ...	—	—	—	—	—	—	35	91	33	83
Yola	32	82	33	79	—	—	36	80	24	84
Keffi	—	—	—	—	—	—	36	80	36	85
Zungeru	31	85	38	82	39	84	44	89	33	86
Ibi	31	81	40	84	—	—	55	79	39	80
Baro	—	—	—	—	55	83	59	77	58	84
Lokoja	57	78	61	78	73	84	64	81	59	80
Ilorin	55	81	61	81	63	88	65	81	51	85
Ankpa	—	—	—	—	58	88	67	85	64	86

Another factor which must be taken into account is the degree of humidity in the various districts. Table C has been added to show the available records for the years 1906–1910. It is unnecessary to analyse these in any detail, but the following observations may bring out the salient features:—(1) The variations in the maxima are very slight as compared with the minima; for example, in 1909, the highest and lowest maxima are 85 and 76, and the highest and lowest minima are 67 and 24, while the corresponding numbers for 1910 are 86 and 70, and 64 and 24. (2) The contrast between Geidam and Ankpa, referred to above, is again emphasised. At the former station, the difference between the maximum and minimum for one year was 57 degrees in 1909, and 54 degrees in 1910, whereas at the latter the corresponding differences were only 18 degrees and 22 degrees.

Table D.

Monthly Temperatures for 1909.

		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maiduguri	Max.	100	107	112	109	112	102	99	94	101	102	102	98
	Min.	49	53	58	66	71	69	68	67	68	65	60	54
	Mean	73	81	89	89	92	86	81	80	82	83	81	75
Geidam ...	Max.	101	106	110	110	109	102	100	93	103	107	105	101
	Min.	46	51	55	64	72	70	68	67	68	63	60	53
	Mean	70	79	87	89	91	85	82	79	83	85	82	75
Sokoto ...	Max.	99	101	105	109	106	100	92	92	98	100	98	94
	Min.	54	60	75	70	70	69	70	68	68	68	64	55
	Mean	75	82	90	89	88	83	80	76	76	84	80	75
Kano ...	Max.	90	96	107	109	106	99	95	96	96	99	99	98
	Min.	47	56	60	65	67	64	67	63	67	61	52	53
	Mean	68	76	85	87	87	81	79	76	80	81	76	72
Yola ...	Max.	99	104	107	103	101	92	90	90	90	96	98	96
	Min.	58	65	72	69	69	66	66	67	67	68	63	61
	Mean	79	86	89	85	83	79	76	77	78	81	82	78
Birnin Kebbi	Max.	97	102	105	104	102	95	96	87	92	96	97	92
	Min.	48	56	70	70	60	70	72	70	70	70	62	53
	Mean	73	80	89	88	84	82	81	77	80	81	79	74
Bauchi ...	Max.	96	100	105	104	100	94	92	89	94	96	95	92
	Min.	49	67	68	64	60	35	57	59	61	66	64	62
	Mean	74	89	86	83	80	76	74	76	77	79	79	78
Baro ...	Max.	100	103	105	101	102	98	96	92	94	102	101	98
	Min.	59	71	71	71	71	67	71	68	70	71	71	65
	Mean	84	88	88	85	85	83	81	80	81	84	86	83
Zungeru	Max.	100	101	103	101	99	95	91	92	93	96	100	99
	Min.	61	66	71	70	69	69	67	68	68	67	56	60
	Mean	81	85	87	84	83	81	78	77	79	81	80	79
Lokoja ...	Max.	99	100	100	97	97	94	89	92	95	95	96	95
	Min.	58	68	72	70	70	66	69	70	68	70	70	61
	Mean	82	85	86	84	83	80	79	79	80	83	85	81
Ilorin ...	Max.	97	99	98	100	98	94	92	92	90	95	99	102
	Min.	53	71	68	67	68	66	67	68	67	65	66	52
	Mean	80	84	84	82	82	80	77	78	78	80	82	78
Ankpa ...	Max.	93	95	96	92	90	88	84	84	87	90	93	91
	Min.	57	62	67	67	63	63	65	65	64	65	64	56
	Mean	77	81	81	78	76	75	75	75	74	76	79	76

The above Table gives the monthly maximum, minimum, and mean shade temperatures for twelve stations for the year 1909, and must be taken in conjunction with the rainfall and humidity. I do not propose to analyse the data in detail, but would point out that the stations have been arranged in the order of descending maxima. It will be seen that this is also approximately the order of

ascending minima, and follows very closely the order of ascending annual rainfall. At one end of the scale are Geidam, Maiduguri, and Sokoto, and at the other Lokoja, Ilorin, and Ankpa. A study of the Table will, however, reveal many other interesting comparisons, all of which are relevant, in a minor degree, to the questions under consideration.

III. Population and Tribes.

Politically, Northern Nigeria is divided into thirteen provinces* of very unequal size. The extent of these and the enormous difference in the density of the population in the various provinces will be seen from the following table.

Province.	Area in Square Miles.	Capital.	Population.
Sokoto	35,400	Sokoto	600,000
Kano	28,600	Kano	2,400,000
Bornu	32,800	Maiduguri	400,000
Bauchi	23,200	Bauchi	709,100
Zaria	15,800	Zaria	179,000
Niger	12,500	Zungeru†	226,800
Kontagora	27,000	Kontagora	75,500
Ilorin	6,300	Ilorin	163,600
Kabba	7,800	Lokoja‡	184,900
Bassa	7,000	Ankpa	175,000
Nassarawa	17,900	Keffi	161,100
Muri	25,600	Amar	584,000
Yola	15,800	Yola	30,000
Total	255,700	Total	5,889,000

Any discussion of the origin of the numerous tribes which inhabit the Protectorate would be out of place here, but at the same time it is essential to know something of the leading tribes, their distribution, and the differences in their pursuits and mode of living.

By far the most important race are the Hausas, who are supposed to have come from the east, and to have penetrated the Western Sudan from the North. The whole of the Northern part of the Protectorate is sometimes designated by the name of "Hausa Land." The Hausas are essentially a trading people, and as their itinerant nature has induced them to visit the remote parts of the pagan countries, they have thus created trade routes in all directions. Consequently, Hausa villages are to be found all over Northern and Southern Nigeria, for the Hausas do not necessarily bring produce from their own country for trading, but buy in one market and sell in another.

Next in importance are the Fulanis, a tribe whose origin is unknown, but who are supposed to have come from the country near the source of the Senegal

* The data here given are those of 1907.

† The headquarters of the Resident is at Minna and the area and population for the new Niger Province is really that for the old, and now abolished, Nupe Province.

‡ The headquarters of the Resident is at Kabba.

River. They are totally distinct from the negro type; their features are well-marked and fine, and they have a very light complexion, in consequence of which the negroes themselves speak of them as "the yellow men." Over a hundred years ago, this tribe conquered the greater portion of the northern states, Zaria, Kano, Katsena, Bauchi and part of Bornu, so that at one time they might be said to occupy the whole country enclosed in the angle formed by the Niger and Benue. They lead a wandering and pastoral life, grazing large herds and flocks, and continually moving from place to place according to the nature of the feeding grounds. They are closely connected with the Foulahs of the Gambia,* and the two tribes have similar habits.

The Yorubas inhabit nearly the whole of the Ilorin Province, and extend into the Western Province of Southern Nigeria. They are an agricultural people, and claim that all the pagan tribes in Hausa Land are descended from them.

The people of Borgu are probably of Berber descent, and, as at present constituted, are a very mixed tribe.

The Yauris have their centre at Yelwa on the Niger, and are an agricultural and pastoral people.

Bornu was not associated with the old Hausa and Fulani States of the Western Sudan, but may be considered a Central Sudan State. The main portion of the people came from the east of Lake Chad and expelled the Fulani, who attempted to over-run this province. The present inhabitants of Bornu are probably not aborigines, but a mixed tribe with an Arab ancestry.

The Nupes are the descendants of a very powerful tribe which inhabited the central portion of the colony, but which was over-run by the Hausas and Fulanis.

The Gwaris are a scattered race, living amongst the rocky hills and caves in the country lying to the South of Zaria (see p. 331).

The Igbaras inhabit the country surrounding the confluence of the Benue and the Niger, while further up the Benue are the Bassas on the right bank and the Akpotos on the left, followed by the Aragos and the Munchis. These latter are a very unapproachable and vindictive tribe, and their country is anything but subdued, although recent expeditions have done much to open it up. Consequently, very little is known of this part of the country.

Further up the Benue lies the Jako country, while higher still, in the upper reaches, are the numerous wild Batta tribes.

IV. Narrative.

(*a.*) The River Niger

During my tour in Nigeria, I traversed the whole of the Niger from its mouth to Yelwa, a town not far from the point where the river enters British territory, and the following notes are based on observations made at different times. Although various parts were traversed in different directions, sometimes up-, sometimes down-stream, and some portions more than once, I have included all records and observations in one general description, and have purposely made

* Bull. Ent. Res., ii., pt. 3, p. 194.

a start at Yelwa, so that in my next report (on Southern Nigeria) the description of the Niger from Idah to the sea will form a consecutive account with this.

The River Niger rises in the Kong Mountains near the borders of Sierra Leone, about 200 mile from the coast. It first runs in a north-easterly direction to Timbuktu (in 16° 40 North and 2° 40′ West), a distance of nearly 500 miles. It then turns eastwards for about 150 miles to Buram Island, and afterwards south-easterly to Yelwa, a distance of over 450 miles. It is on this last stretch that it enters Northern Nigeria, near the small village of Tunga, which is about 100 miles from Yelwa. From Tunga to the sea is roughly 700 miles, while from the source to Tunga is almost 1200 miles. From Yelwa it runs almost due south to Jebba, then eastwards to Baro, and from this point nearly due south to Southern Nigeria, which it enters at Idah, 289 miles from the coast. South of Abo, in Southern Nigeria, it spreads into an enormous delta with an intricate network of channels and creeks, and its various mouths extend over 200 miles of the coast. Its total length is therefore about 1900 miles, of which 1200 miles are outside British territory, 420 are in Northern, and 280 in Southern Nigeria.

Tunga to Yelwa.

This part of the river I was unable to examine, and as no blood-sucking flies have been recorded from this stretch, I shall content myself with quoting a short description* for the sake of completeness. "At Yelwa, the banks become low and swampy, the hills begin to recede from the river, and five miles further on, near the village of Sakassi, the last set of minor rapids (*i.e.*, from south to north) occurs in the channel. Beyond Sakassi, the whole aspect of the river changes, the channel becomes broad and sandy, and is obstructed by nothing more serious than sand-bars. On the north bank a broad, swampy plain, with low rising ground in the distance, bounds the river as far as the mouth of the Kebbi. From Kebbi to the swamps of Illo, an open sandy plain stretches northwards between the river and the base of the plateau. On the south bank, the gently undulating plain which bounds the river stretches westward to the Dahomey border, broken only by some scattered groups of low-topped hills."

Yelwa to Jebba.

This journey can be accomplished only in native canoes, and even by this means only during the season of highest water in the river, that is after the middle of the rains, owing to the numerous rocks which occur, and the number of rapids to be traversed. Six days were spent by the writer on this part of the river, and two at Bussa, the whole trip lasting from the 14th to the 21st of September. This method of examining a river is undoubtedly the best, as the rate of locomotion is slow, and it is possible to keep close in to the banks and land at any point which seems to merit special attention. The valley of the Niger from Yelwa to Ineku is wide and bounded by low hills with scanty forest growth; at Ineku the river divides into two and encloses a large and extensive island, which stretches to Warra, where the two channels again join into one broad slow-flowing stream, with a wide flood-plain covered with long

* From "The Geography and Geology of N. Nigeria," by J. D. Falconer.

grass and low shrubs. After Warra, a few rocks begin to appear in the river, but navigation is comparatively easy until Bussa is reached. Two days were spent on this part, and although the river bank was carefully examined, no biting flies of any sort were seen, with the exception of a species of *Simulium* at Otono, where a halt was made for the night. The day was dull, however, and this may to some extent account for the absence of insect life. At Bussa, the vegetation on the bank is very dense, and there is also abundant grass. In and around a banana plantation, close to the river, *Glossina palpalis* was caught, while nearer the Resident's house, which is situated some distance from the river, *G. tachinoides* was extremely abundant. Other blood-sucking flies obtained here were:—*Stomoxys nigra*, *Banksinella lutcolateralis* and a large new species of *Tabanus*, as yet undescribed. The Resident at Bussa, Mr. P. de Putron, informed me that it is almost impossible to keep horses in this district, as they invariably die a few months after their arrival.

Southwards from Bussa, there are numerous rapids, and navigation is both difficult and dangerous. Immediately after passing the town of Malali, the channel is obstructed by projecting rocks and there is a stretch of cascades and whirlpools, which extend for about three miles to the town of Garafini; there *G. tachinoides* was caught.

After Garafini, there is a stretch of about 20 miles of smooth water: the banks are covered with low shrubs, backed by higher trees. No biting flies were seen in this part, but the fact that the morning was dull and that some rain fell about mid-day, may account for their absence. When passing the mouth of the Kontagora River* we caught one *G. tachinoides*, and another specimen of the same species, near the mouth of the River Oli. In this region are the rapids of Patassi, which are "composed of two sets of cascades each twelve to fifteen feet in height and separated by a straight reach of some two hundred and eighty yards." Following this is a stretch of two and a half miles of comparatively smooth water, after which are the Great Rapids of Wuru. "Here the river is formed of two branches with a rocky island between. The fall of forty feet between the summit and the foot of the rapid is distributed over some 1300 yards of river, giving a slope of at least 1 in 100, and a current of from fifteen to eighteen miles an hour. In the rains, the granite boulders are completely submerged under a seething flood, and even in the dry season the water is thrown up by the projecting rocks in sheets of foam, and the roar of the rapid is heard for long distances on either side."† Near these rapids *G. tachinoides* is abundant.

From Leaba to Bajibo, there are numerous rocks in the river, but though navigation is difficult, it is not very dangerous in the rains. No biting flies were seen on this stretch, but the day was again dull. Bajibo is the extreme limit to which small stern-wheelers can ascend the Niger even in the wet season, and then only with great risks. Between this town and Jebba, *G. tachinoides* simply swarms, and as many as 25 or 30 invaded the canoe at one time. The banks of the river

*It may be useful to note here that a specimen of *G. palpalis* was caught by Mr. P. de Putron, the Resident at Bussa, at Kulfu on a branch of the Kontagora River on 26. VI. 10.

†"The Geography and Geology of Northern Nigeria."

are covered with long grass and thick low shrubs close down to the water's edge, while behind this is a dense fringe of thick bush (Pl. VIII, fig. 1). I went ashore at several places, and everywhere *G. tachinoides* swarmed, while in the thick bush behind, one *G. palpalis* was caught.

For the last 800 yards before reaching Jebba, the river is enclosed in a narrow gorge with almost vertical walls: it is divided in two by the high steep-sided "Juju" rock (Pl. VIII, fig. 2), the current being both deep and swift, with numerous eddies and whirlpools.

Jebba to Mureji.

This journey was accomplished on the 11th of October in a very small steam-launch. The nature of the vegetation on the river banks is very similar to that around Bajibo. In some parts heavy bush predominates, and there *Glossina palpalis* swarmed: at other places where there is abundant grass and low shrubs, *G. tachinoides* was seen (Pl. IX, fig. 1).

At the town of Mureji itself, both *G. palpalis* and *G. tachinoides* were caught. On another occasion (August 16th) I visited this town, which is nothing more than a few houses situated on a mud bank, so that at low water it stands a few feet above the level of the river, but during the rains the various houses are separated by deep channels filled by the rising river (Pl. IX, fig. 2). Mosquitos were abundant in August and by far the most frequent were *Mycomyia costalis* and *Stegomyia fasciata*. *Tabanus taeniola* and *T. latipes* were also caught at the same time. The chief importance of this village lay in the fact that it is situated at the junction of the Kaduna and the Niger, and all launches for Barijuko, the Kaduna landing-place for Zungeru, took in fuel there; but since the opening of the Baro-Kano Railway, this route has been abandoned, and the only launches which call there now are those plying between Jebba and Baro.

On the river Kaduna, between Mureji and Barijuko, *Tabanus taeniola* and *T. latipes* were the only blood-sucking flies seen during my trip, but both *G. palpalis* and *G. tachinoides* have been caught in this region, and these records are shown on the accompanying map.

Although I traversed the river between Mureji and Baro on two occasions, I was unable to form any opinion of this part, as both trips were done by night. Both *G. palpalis* and *G. tachinoides* have, however, been recorded from this region (see map). The town of Baro has been discussed elsewhere, so requires no mention here. The journey from Baro to Idah was made in a large stern-wheeler, which is not nearly so satisfactory for entomological purposes, as it seldom approaches close enough to the banks for flies to come aboard, and the rate is also a deterrent to such intrusions. With the exception of several *Tabanus latipes* and *T. taeniola* caught south of Baro and *T. fasciatus* near Itobe, no blood-sucking flies were seen on the steamer. Both *Glossina palpalis* and *G. tachinoides*, however, have been found on this stretch, and the localities of these are also shown on the map.

(*b*) **Lokoja.**

The town of Lokoja is, and always must be a very important commercial centre, inasmuch as it is situated at the junction of the two large rivers, the Benue and the Niger, and therefore commands the whole of the trade of the

eastern half of the Protectorate. It is also an important political centre, and all officers stationed on the Chad and Benue systems must pass through Lokoja going to and from their stations. Here also is situated one of the three large European hospitals of the Protectorate, under the charge of a Senior Medical Officer. Further, it is the headquarters of the 2nd Battalion of the West African Frontier Force. All these combined together ensure a large permanent European population as well as a continual ingress and egress of officials and others passing north and south.

The town stands on the right bank of the Niger, at the base of a large flat-topped hill, Mount Patti, which is covered with moderately thick bush. On the left bank is a large, flat, alluvial plain formed by the confluence of the two rivers. Close to the river are several trading factories, the Marine Headquarters, and the stores of the Public Works Department, and, owing to the nature of the bank and the varying level of the river, pools of stagnant water are far from infrequent, in many of which mosquito larvae were found. Mosquitos are very troublesome all over this part, and swarms of them come from the banks and invade the steamers lying alongside. In four buildings occupied by Europeans, as well as on a launch tied up to the bank, I found *Stegomyia fasciata* and *Myzomyia costalis*. The majority of the European houses are on much higher ground, and at some distance from the river: but in the Post Office, some five hundred yards from the river bank, *S. fasciata* was seen. Throughout the town, the most prevalent mosquito was *M. costalis*.

Glossina palpalis has been recorded from Lokoja, but although I visited this town on two different occasions, first in August, during the rains, and afterwards in January, in the dry season, I saw none, and from the nature of the clearings so efficiently carried out by the political and medical officers, I do not think that this species actually breeds within the limits of the settlement, but it may occasionally follow natives or others from the bush on Mount Patti. During my second visit, Dr. E. A. Chartres, the Senior Medical Officer, was clearing a small banana grove which existed in a low-lying, damp situation, but careful search failed to reveal either the insects or pupal cases. In June, 1911, Dr. Chartres caught a specimen of *G. tachinoides* near his house, and in August of the same year one *G. palpalis* inside a ward of the European Hospital.

Ticks are said to be very troublesome at certain seasons of the year; both *Amblyomma variegatum* and *Rhipicephalus sanguineus* have been recorded from the district. *Culicoides sp.*, and *Simulium sp.* are abundant. *Myzomyia costalis*, as has been mentioned, is the most prevalent mosquito, but apart from this species and *Stegomyia fasciata* near the river, the only others seen during my visit were *Mansonioides uniformis*, *Mucidus mucidus* and *Nyssorhynchus pharoensis*. Dr. Chartres has, however, collected the following species since that time:—*Culex decens*, *C. grahami*, *C. guiarti*, *C. invidiosus* and *Myzomyia umbrosa*. *Hippocentrum versicolor* has been recorded from Lokoja, but is far from common, while in and near the stables *Stomoxys nigra*, *S. calcitrans* and *Hippobosca maculata* simply swarm in hundreds.

The number of horses in Lokoja is necessarily large, and the rate of mortality is excessively high. Capt. Manuk, late I.M.S., who has made a special study of

this subject extending over a long period, informed me that of the horses brought into Lokoja over 60 per cent. developed trypanosomiasis within a year, and of these 50 per cent. died within the same period. The question naturally arises: What is the carrier? It must be remembered that these horses are very seldom taken out of the station, and consequently must be infected within that area. As has been mentioned, *Hippocentrum versicolor* does occur, though in small numbers, but the most prevalent horse-biting flies are *Stomoxys nigra* and *S. calcitrans*, whereas *Glossina submorsitans* has never been seen in Lokoja.

These facts apparently point to *Stomoxys* as the carrier, and since we have no direct evidence, experiments should certainly be made to prove or disprove this possibility. But, apart from this, the fact remains that at present two out of every three horses brought into Lokoja are incapacitated for work within a year of their arrival, and it is almost superfluous to emphasise the necessity of trying, so far as possible, to reduce the chances of infection by instituting a segregation camp and making the stables mosquito-proof. To this subject, as well as to the question of launches as agents in the dissemination of mosquitos, I shall refer later on.

(*c.*) Offa to Zungeru.

The greater part of this journey was made by railway, and as by this means it is possible to examine only the chief towns "en route" I shall here content myself with giving a few general notes and the records of blood-sucking insects so far available. The town of Offa is situated on the boundary of Southern and Northern Nigeria and is connected with Lagos in the south and Jebba in the north by the Lagos Government Railway. The biting flies recorded from this station are:—*Myzomyia funesta*, *M. costalis*, *Hippocentrum versicolor*, *Tabanus secedens*, *T. subangustus* and *Tabanus sp. nov.* near *kingsleyi*. The only ticks recorded are *Aponomma exornatum* and *Amblyomma nuttalli*, of which Dr. R. C. Hiscock obtained specimens from a large monitor lizard (locally called an iguana) captured near the European quarters.

Northwards the next important town is Ilorin, and here the following insects were obtained:—*Myzomyia costalis*, *Myzorhynchus paludis*, *Trichorhynchus* (*Culiciomyia*) *nebulosus*, *Reedomyia annulata* and *Culex sp. indet.*

At Jebba the only blood-suckers seen were *Myzomyia funesta*, *M. costalis*, *Glossina palpalis* and *Tabanus taeniola*. The town of Jebba is now connected with Zungeru by what is known as the Northern Extension of the Lagos Railway, but at the time of my visit this line was under construction. Through the kindness of the Director I was, however, enabled to examine this area as far as Charati, the terminus at that time, and the following records were made during several excursions by trolley.

At Gana, on the left bank of the Niger, from which the photograph shown in Plate VII, figure 2, was taken, *G. palpalis* was far from uncommon, and this species occurs at several places before reaching Mokwa. The railway skirts for a considerable distance a large expanse of water known as Lake Tatabu, which is not surrounded by much dense shade, but everywhere high grass is predominant. Throughout this whole region *G. tachinoides* is extremely abundant.

At Bokani the only blood-sucking flies seen during my visit in October were *G. tachinoides* and *Haematopota lacessens*, but *Rhipicephalus simus* and *Ctenocephalus canis* were very abundant on dogs. *G. tachinoides* was also obtained at Gudu Gudu. Dr. J. W. Archibald, who was stationed at Bokani and afterwards at Jebba, sent in a number of species, but as the only data accompanying them were "Jebba and Bokani 1910" it is impossible to determine the precise locality of each. It may be advisable, however, to enumerate them here :—*Myzomyia funesta*, *M. costalis*, *Mansonioides uniformis*, *Glossina palpalis*, *G. tachinoides*, *G. submorsitans*, *Tabanus biguttatus croceus*, *T. fasciatus*, *T. latipes*, *T. ditaeniatus*, *T. par*, *Tabanus sp. nov.* and *Hippobosca maculata*.

(*d.*) Zungeru and its Environs.

The town of Zungeru (locally known as the cantonment) is situated on the right bank of the River Kaduna, and is the seat of administration of Northern Nigeria. I do not propose to enter into a lengthy description of this town, but shall draw attention to only a few of the most important points in connection with the blood-sucking insects which occur there, and the possible causes of their existence and abundance. It might be well, therefore, to enumerate these at this stage.

Family Tabanidae.

Tabanus biguttatus croceus.
„ *ditaeniatus.*
„ *gratus.*
„ *pertinens.**
„ *nyasae.*
„ *taeniola.*
Tabanus par.
„ *thoracinus.*
Haematopota decora.
„ *pallidipennis.*
„ *tenuicrus.*
Chrysops distinctipennis.

Family Muscidae.

Stomoxys calcitrans.
„ *nigra.*
Lyperosia minuta.
Glossina palpalis.
„ *tachinoides.*
„ *submorsitans.*

Family Culicidae.

Section Anophelina.

Myzomyia umbrosa.
„ *costalis.*
Myzomyia funesta.
Myzorhynchus mauritianus.

Section Culicina.

Culex tigripes var. *fusca.*
„ *quasigelidus.*
„ *invidiosus.*
Trichorhynchus (*Culiciomyia*) *nebulosus.*
Stegomyia sugens.
Mansonioides uniformis.
Toxorhynchites brevipalpis.

* Described by Mr. E. E. Austen on page 286 of this volume.

Family Hippoboscidae.

Hippobosca maculata.

Family Pulicidae.

Ctenocephalus canis.

Family Ixodidae.

Amblyomma variegatum.
Haemaphysalis leachi.
Rhipicephalus simus.
„ *appendiculatus*
„ *sanguineus.*

Zungeru is situated in the valley of the Dago River, near its confluence with the Kaduna. These two rivers are separated by a high ridge, on which is situated the European Hospital and the medical quarters, the area between this ridge and the Kaduna being covered with dense bush. From the ridge to the River Dago the whole area is cleared, and here are situated several bungalows and the Prison. The European military quarters are on the right bank of the Dago River and the Government Offices on the left bank, the latter in the most low-lying part of the cantonment. Over some of these offices there are European residential quarters, while on the ascending ground of the left bank stand the remaining bungalows, culminating in Government House near the top of the ridge. The polo ground is situated near Government House on a small plateau, and on the other side towards the River Dago lies the Prison farm.

The site of the cantonment is therefore such as to make the work of the sanitary officer a very arduous one, when he has to undertake clearing measures, and, for this reason, in spite of almost continual work, tsetse (*G. palpalis*, *G. tachinoides* and *G. submorsitans*) are nearly always present within the limits of the cantonment, but more numerous during the rains. The proximity to the Kaduna, which swarms with tsetse in its lower reaches, renders the task of preventing these insects from invading the town a very difficult one, but in addition to this the River Dago must be taken into account, along with the surrounding bush, through which roads radiate in all directions. Again, the railway now enters Zungeru across the Kaduna from Jebba, and, passing along the side of the cantonment, continues onwards to Minna and the north. This latter fact constitutes an additional danger, and must not be overlooked.

As has been said, the cantonment itself is very efficiently cleared, but the sanitary gang as at present constituted can do little more than look after this part, while what is urgently required is an extensive clearing between the medical lines and the Kaduna, a similar clearing on the banks of the Kaduna on both sides of the new railway bridge, and a continuation of the clearing on the Dago River; in fact, a clear belt around the whole cantonment, and this can be done only by systematic and continued work carried on by a large supplementary sanitary gang. This is perfectly well recognised by the Medical and Sanitary Departments, but owing to the small number of men assigned to this work no action can be taken. Now that Zungeru is linked up by railway with Lagos and Kano, the number of Europeans passing through it will be greater than ever,

and the dangers are therefore accentuated; some such measures as those suggested should immediately be put into effect.

During my own stay in Zungeru I caught several *Glossina palpalis* at various places within the cantonment, in some cases within a few yards of European bungalows, and several medical officers have obtained the same species at other places. It is more than probable that these do not actually breed in the town, but come in from the surrounding bush. Mosquitos are far from uncommon in Zungeru, but are more abundant along the valley of the Dago River than on the higher ground. If at all possible, the residential quarters over the Government Offices in Ike Square should for this reason be abolished. Two species of *Stomoxys*, namely *calcitrans* and *nigra*, are omnipresent, and are a perfect pest and a probable source of danger to ponies, while the number of species, as well as of individuals, of the smaller TABANIDAE, is excessively large, especially near the polo ground. The clearing already suggested should tend to reduce these to a minimum.

Trypanosomiasis is very common amongst horses in Zungeru, and there can be little doubt that many become infected within the cantonment. Not long ago a camp was started near the polo ground for transport cattle, but this had to be abandoned owing to the high rate of mortality. There is at present a trypanosomiasis camp for ponies, but it is situated too close to the Kaduna, and might with advantage be removed to higher well-cleared ground. In the interest of the Protectorate such camps ought to be officially recognised and aided.

Piroplasmosis also is known to occur in dogs, but no records are available to show whether or not this disease accounted for any of the deaths in the cattle transport lines.

I should like here to draw attention to one of the regulations of the cantonment, namely, that prohibiting the shooting of any game, large or small, within three miles of Zungeru. In consequence of this, small antelopes may often be seen within the bungalow enclosures. The question as to whether or not this regulation should be continued must necessarily depend on whether these animals are or are not a source of danger. For the present we are not in a position to make any definite statement, but the blood of these animals should be examined for protozooal parasites, and in view of the high mortality amongst horses, inoculation experiments with *Stomoxys* and TABANIDAE should also be carried out. It is not at all improbable that such game may act as protozoal reservoirs, and that their presence around the cantonment may to a great extent account for the infection of the ponies. Should this be proved to be the case, it is obvious that such a regulation should be at once withdrawn.

The following extracts from a letter sent me by Dr. W. Morrison will give some idea of the country immediately surrounding Zungeru :—"Konoko is a small village of about 30 huts, situated near Wushishi, about 8 miles from Zungeru [see map]. The general bush is more open than one finds elsewhere, but there are a number of kurimis [p. 307, *supra*], usually with a collection of pools of water along the whole extent, and thick dense bush and trees on either side, while the lowest parts are swampy. Near these places tsetse were more numerous than in any other place I have seen, and I have counted over a dozen

on my boy's back at one time. Besides tsetse, *Hippocentrum*, *Tabanus*, *Haematopota* and also *Hippobosca*, absolutely covered my pony's belly, and in a short time hundreds of these could have been caught. Needless to say, my pony developed trypanosomiasis: I examined his blood daily, and on the sixth day found trypanosomes. Harnessed antelope, bush-cow, hartebeeste, water-buck, duiker, oribi and pig, are abundant." The insects collected by Dr. Morrison during his stay there include *Mansonioides uniformis*, *Tabanus taeniola*, *T. fasciatus*, *T. biguttatus croceus*, *T. ditaeniatus*, *T. par*, *Hippocentrum versicolor*, *Haematopota gracilis*, *H. lacessens*, *H. bullatifrons*, *Glossina submorsitans* and *Hippobosca maculata*.

The presence of these in close proximity to Zungeru more than ever emphasises the necessity of having an extensive clearing separating such haunts from the cantonment.

(*e.*) Zungeru to Yelwa.

This part of my tour was accomplished between August 30th and September 11th under somewhat trying conditions. It being the height of the rainy season, the rivers were much swollen, and many of the swamps were almost impassable. Rain fell persistently the whole day during four marches, and thus rendered work practically impossible.

The country varies slightly in character at different parts, but the general altitude may be taken roughly at 1000–1300 feet above sea level. Immediately after one leaves Zungeru, the River Kaduna is crossed, but with this exception the road to Garan Gabbas, about 7 miles from Zungeru, is practically level and runs through thin, open bush country. Bush-fowl and guinea-fowl are everywhere abundant on the route, and near Garan Gabbas itself a considerable troop of large red monkeys was seen. The following blood-sucking insects were captured on the pony between 4 and 6 p.m.:—*Hippobosca maculata*, *Stomoxys nigra*, *S. calcitrans*, *Haematopota bullatifrons* and *Hippocentrum versicolor*. The first four species were abundant, but of the last only one specimen was seen. Heavy rain fell during the night and up to 9 a.m. The following day was dull and very few insects were seen. Between Garan Gabbas and Tegina, *Hippobosca maculata*, *Stomoxys nigra* and *S. calcitrans* were found on the pony, while at Tegina itself two *Hippocentrum versicolor* were captured, along with one *Haematopota bullatifrons*. This last species is a most voracious feeder. It darts down and immediately sets to work; the puncture made by the proboscis is very large, and if the insect be disturbed while feeding, a stream of blood generally oozes out. A species of *Simulium* and a *Culicoides* occur at Tegina. The native dogs were almost covered with ticks, and the following species were found:—*Rhipicephalus sanguineus*, *R. simus* and *Haemaphysalis leachi*; while one species of flea, *Ctenocephalus canis*, was also obtained from the same source.

Before we left Tegina in the morning, one specimen of *Tabanus subangustus* was caught flying around the lamp on the table at 5 a.m. The journey from Tegina to Mariga was far from good at this season of the year. Practically half of the road was under water, and some parts were very swampy and

in many places the pony extricated itself from the mud only with difficulty. In such swamps *H. versicolor* is practically always found. The River Mariga is crossed in canoes, but no blood-sucking flies were seen here, although two hours were spent in transferring loads and carriers. Plate X. illustrates the type of vegetation on the banks of the rivers in this part of the Protectorate. About half a mile further on is Mariga, a small town of about 200 inhabitants. Around the houses in the native town large pools of water were everywhere seen. These contained innumerable mosquito larvae and pupae, but careful search failed to reveal any imagines in the houses themselves. The larvae and pupae collected here have not yet been identified. One *Tabanus subangustus* was captured flying around the lamp on the table in the rest-house at 8 p.m.

While we were encamped at Mariga, it rained heavily and persistently throughout the whole night and up to about 9 a.m. The road to Bobi is very similar to that between Tegina and Mariga. There are numerous swamps and running streams, and two fairly large rivers have to be crossed. One, about a mile from Bobi, is very swift and deep, but not broad: here one specimen of *T. subangustus*, was captured at noon. Three species of *Haematopota* were caught at Bobi: *H. bullatifrons*, *H. lacessens*, and two specimens of a species not yet described.

The country from Bobi to Baeri is covered with moderately thick bush, but towards Baeri it is hilly. The road passes through numerous swamps, but there are no large rivers to be crossed. During the journey, *H. bullatifrons* and another specimen of the new species referred to above were caught. At Baeri *Tabanus albipalpus* and *T. subangustus* were secured. In the rest-house book the following note, dated 17. v. 07, appears: "Tsetse-fly is found here"; but none was seen during my visit on 3. ix. 10. On my horse were found several *Amblyomma variegatum*.

The road from Baeri to Kontagora (20 miles) is through thin bush country and practically level; four miles from Baeri, the Igberi River has to be crossed by means of calabashes. No blood-sucking insects of any description were seen during this journey.

Kontagora is a large town of over 4000 inhabitants and is the headquarters of the Province of the same name. It stands about 1300 feet above sea-level, and is probably the highest point between Zungeru and Yelwa. Rivers to the west of this point, *e.g.*, the Kontagora River, flow in a south-westerly direction directly into the Niger, while those to the east, *e.g.*, the Igberi River, flow south-easterly into the Kaduna, which itself is a large tributary of the Niger. The Residency is situated about two miles from the native town, and the surrounding district, though swampy in parts, is well cleared. The only blood-sucking fly seen was *Hippobosca maculata*, and this occurred in numbers around horses: numerous *Rhipicephalus simus* were also found on these. A jigger, *Dermatophilus penetrans*, was obtained from the foot of a native. In the hospital, however, numerous flies, collected some time previously by medical officers and residents in this province, were examined and the data of these ought to be recorded here. From Kontagora itself, the only species were *Tabanus biguttatus croceus*, collected by Dr. McKinney in August, 1910, and *Myzomyia costalis*, collected

by Dr. W. D. Inness. The following species from the surrounding districts were also collected by Dr. W. D. Inness :—

Glossina palpalis at "Yelwa Ford on the Kontagora River" (5. x. 09).
Glossina tachinoides ,, "Kontagora River, 1 mile S.W. of town" (26. viii. 09).
,, ,, ,, "Valley of Kontagora R., between Mudangi and Adala" (7. viii. 09).
,, ,, ,, "Banana plantation at Adala, on Kontagora R." (8. viii. 09).
,, ,, ,, "Yelwa Ford, Kontagora R." (5. x. 09).
Glosina submorsitans ,, the first three localities cited for *G. tachinoides*, on the same dates.

Mr. P. de Putron, the Assistant Resident at Bussa, also collected specimens of *G. palpalis* at Kulfu, and *Tabanus par* at Jeri. Both these places are in the Bussa District of the Kontagora Province. All the above records have been included on the map.

From Kontagora to Yelwa, the country varies in character at different parts, and is much more hilly than the previous section, especially when nearing the valley of the Niger. The first part of the road, namely to Osubu,* is fairly level and swampy, with a considerable amount of scrub. One specimen of *Glossina palpalis*, the first on this trip, was caught close to one of the swamps, in a cluster of dense bush. The headquarters of the Kontagora Province used to be at Osubu, but were removed in 1905 for various reasons, one of which, according to the Resident, being the enormous mortality of horses in the station. The roads, grass and bushes were swarming with small ticks, and a walk in the grass resulted in one's legs being simply covered with them; it is often stated that these will not bite man, but the writer's experience does not in any way bear this out. The species found were *Rhipicephalus sanguineus*, *R. simus* and *Haemaphysalis leachi*. *G. palpalis* occurs in numbers in Osubu.

The road to Massamabu passes through open country with abundant high grass and thin scrub. About half-way, the River Kontagora, which runs south-west and joins the Niger nearly opposite the junction of the River Oli with the latter, has to be crossed by means of rafts. While waiting here, I secured one specimen of *G. palpalis*. At and around Massamabu the following blood-sucking insects were caught :—*Tabanus subangustus*, *Haematopota bullatifrons*, *H. lacessens*, *H. puniens*, *Glossina palpalis*, *G. tachinoides* and *Simulium sp.* *Simulium* was especially troublesome between 4 and 6 in the evening. When this insect has finished feeding, a small drop of blood is generally left adhering to the wound. The position of the bite is afterwards indicated by a bright red spot, surrounded by an irregular discoloured purplish area which remains for several days.

Heavy rain fell throughout the night, but early in the morning it cleared up. No sooner, however, had we started for Anaba than a downpour commenced, and continued the whole day. Work was impossible, so a halt was made at Ibeto. No flies of any description were seen. About 10 o'clock next morning, the rain having partially stopped after 39 hours' continuous downpour, a start was again

* Osubu is not marked on the map, but lies about four miles from Kontagora.

made for Anaba. The road in this part is rocky, and trekking was difficult owing to numerous streams which were considerably augmented by the recent rain. There is also a large amount of thick scrub in this region. When crossing the River Watta about a mile from Ibeto at 10.30 a.m., I secured a specimen of *T. subangustus*, and one of *H. bullatifrons*. From 11 a.m. to 3 p.m. another tropical shower was experienced, but after that it cleared up sufficiently for outdoor work to be recommenced.

At Anaba the following were captured:—*Stomoxys nigra*, *S. calcitrans*, *Haematopota decora*, *H. bullatifrons*, and one specimen of a new species of *Haematopota* (near *decora*), not yet described. These were all caught late in the afternoon, while *Tabanus subangustus* was captured flying around the lamp in the kitchen at 7 p.m.

The road from Anaba to Ipana* passes through Lebelli; it is very rocky and there is an abundance of thick scrub. There are numerous nullahs and hills and several small streams, which make travelling very arduous. During this march, the following flies were taken, chiefly around the pony:—*Tabanus albipalpus*, *H. bullatifrons*, *H. decora* and *Haematopota sp. nov.* At Ipana, *Hippocentrum versicolor* and another specimen of the new species of *Haematopota* were obtained.

From Ibana to Yauri, the old capital of this district, the road passes through extensive swamps, and at the town of Lafia, the river of that name, sometimes called the Malendo River, is crossed by canoe; it is here 150 yards wide, being deep and with high banks. The first part of the road from Yauri to Yelwa is moderately level, but the latter part is over high rocky hills with loose stones. At Yauri, there is a large number of horses, and this is one of the chief breeding places in this Province, so that it is highly improbable that tsetse occur here; in fact, one would hardly expect to find any owing to the extensive level plain on which the old town was situated, and which is practically devoid of bush or scrub of any sort. At Yelwa, the only two blood-sucking flies seen were *Tabanus taeniola*, caught during the day in the open, and *T. subangustus*, caught around the light in the early morning and late evening.

(*f.*) Baro-Kano Railway.

The town of Baro is situated on the left bank of the Niger, 407 miles from its mouth, and has recently become a very important centre owing to its being the southern terminus of the Baro-Kano Railway, which runs in the valley of the Bako River to Shapa, thence to Kano, *via* Minna. Plate XI gives a general view of the railway terminus and one half of the town, so that it is unnecessary to enter into a lengthy description.

The town itself is situated in an area enclosed by a crescent-shaped plateau, which is generally known as "the Horse-Shoe." On the top of the plateau on the south side are situated the European hospital and several railway bungalows, while on the side of the hill on the north are the quarters of the political department, and the native hospital. These latter may be seen in Plate XI,

* The town of Ipana does not figure on the map, but is situated on the main road about 6 miles from Lebelli.

which also shows the general type of the vegetation. On the side of the railway remote from the town is a large pestilential swamp which is an ideal mosquito-breeding area, and serves to keep up a regular supply of these insects in the town. The authorities are quite alive to the necessity of having this swamp filled in, but have experienced considerable difficulty in the matter, owing to the high position it holds in the local fetish or "ju-ju." It is to be hoped, however, that this difficulty may be overcome in the near future.

I visited this town on two different occasions, and as my own experiences coincide exactly with those of Drs. Ingram, Morrison and Macfie, I shall content myself with giving a list of the blood-sucking flies found at Baro, and an extract from their report to show the nature of things as they exist at this place.

Family Culicidae.

Section **Anophelina.**

Anopheles wellcomei.
Myzomyia funesta.
„ *umbrosa.*
„ *costalis.*
„ *flavicosta.*
Myzorhynchus mauritianus.
„ *paludis.*
Nyssorhynchus pharoensis.
„ *squamosus.*

Section **Culicina.**

Culex quasigelidus.
„ *decens.*
Trichorhynchus nebulosus.
Mansonioides uniformis.
Stegomyia fasciata.
„ *gebeleinensis.*
„ *sugens.*

Family Muscidae.

Glossina palpalis.
„ *tachinoides.*
Glossina submorsitans.
„ *longipalpis.*

Family Tabanidae.

Tabanus biguttatus croceus.
„ *subangustus.*
Tabanus latipes.
„ *taeniola.*

Family Ixodidae.

Rhipicephalus simus.

Drs. Ingram, Morrison and Macfie in reporting on an outbreak of sleeping sickness at Baro, in which five cases were found, say: "We are of opinion that the occurrence of trypanosomiasis is sporadic in Baro. There is, however, to judge from the prevalence of *G. palpalis* at this season of the year (August), no reason why it should not become epidemic.

"An attempt was made to determine the areas in which the different species of *Glossina* occurred. No tsetse-flies were found along the narrow belt of land between the river and the base of the cliff, which is traversed by the road from Sabon Gidda to Baro. This strip of ground is kept fairly well cleared. While very few were encountered on the level ground enclosed by the horse-shoe-shaped plateau where Baro itself is situated, on ascending from this level to the plateau, specimens of *G. palpalis* and *G. tachinoides* are readily found on

the top of the hill, and for about one mile inland the same flies have been frequently taken. Further inland these species are gradually replaced by *G. morsitans* [*submorsitans*], this latter species being found in considerable numbers all over the plateau surrounding Baro. The belt is in places at least 4 miles wide. Hartebeeste is known to occur on the plateau, and buffalo has been shot within recent times. It may be of interest to note that the tsetse-flies appeared to be attracted by grey flannel or sandy-coloured homespun cloth.

"An interesting fact emerges from the above observations, namely that at Baro *G. palpalis* is plentiful at a considerable distance from the river. As regards the relative prevalence of *G. palpalis* and *G. tachinoides*, the former was more frequently met with in the month of August, the latter in September, the number of *G. palpalis* having apparently diminished."

Since the above was written, Dr. Morrison caught one specimen of *Glossina longipalpis* on the top of the plateau.

The new native town of Baro is situated about two miles up the line from the railway headquarters, on the side of the railway remote from the river. Close to the railway there runs a creek for a few miles; the country is thickly wooded and *G. palpalis* is abundant. Onward from the creek the country is much more open, while near Katcha (about 14 miles) there is a large plain which extends

Fig. 1.—Typical open grass country of the savannah type.

for several miles on the left. Towards and around Egga (68 miles), the bush is only moderately thick, while in the vicinity of Kateregi (72 miles) it becomes much thinner, and the soil is sandy. At 79 miles the railway passes within a hundred yards of the river and here *G. palpalis* occurs. This region I traversed

on a trolley from Minna, on November 23rd and 24th. At 84 miles the line runs at a considerable distance from the river, but numerous *G. submorsitans* alighted on the natives on the trolley. No water exists anywhere in this vicinity, and the bush is fairly open, and gets gradually thinner, until at Minna there are only a few stunted trees scattered about (Plate XII, fig. 1 and text-fig. 1). At 98¾ miles there is a large river, on the banks of which the bush is very dense; no tsetse were seen there, but in all probability they exist; while at 103 miles there is a small stream, 20 feet deep during the rains, but reduced to isolated pools in the dry season. There *Glossina submorsitans* was caught, and it is noteworthy that at this point one of the construction camps was situated, and practically every horse brought there died of trypanosomiasis. Dr. Morrison, who did a considerable amount of travelling on this line, writing to me about this region, says: "*Hippocentrum versicolor* and *Tabanus biguttatus* var. *croceus* I have caught at Katcha station, and the former along with *Tabanus taeniola* in the van all along the line. These species enter the vans and carriages, and are thus carried from place to place all along the Baro-Kano Railway."

At Minna, blood-sucking flies of any description are seldom met with. The following species were, however, obtained: *Hippobosca maculata*, *Stomoxys calcitrans*, *Myzomyia costalis*, *Anopheles watsoni*, *Myzorhynchus paludis* and *Mansonioides uniformis*: while the ticks comprised *Hyalomma aegyptium*, *Amblyomma variegatum* and *Rhipicephalus falcatus*. Dr. Macfie informed me that the only Tabanid he had seen during a three months' stay at this station was *T. taeniola*, and it is more than probable that this was carried to Minna in some railway vehicle. There is a large herd of Fulani cattle at Minna, and the death rate is extremely low, which in itself gives an indication of the paucity of such insects as may be implicated in the transmission of disease.

North of Minna, the country through which the railway runs is fairly open, with the exception of a few isolated kurimis. Near Gumi, where the River Dinia is crossed, *Haematopota pallidipennis* and a species of *Tabanus*, not yet identified and probably new, entered the van in which I was travelling. Further on, at Kogin Sirikin Pawa, on the river of that name, numerous *Hippobosca maculata* and *Haematopota pallidipennis* swarmed around the ponies, and one specimen of the *Tabanus* mentioned above was caught; but although I carefully examined about a mile of the banks of the river itself, no tsetse were seen. In the small pools left by the falling river were numerous mosquito egg-rafts, and also large numbers of both Anopheline and Culicine larvae and pupae. One small specimen of *Tabanus*, probably *T. gratus*, was seen but not caught. At the River Kaduna, the terminus of the railway at the time of my visit (Pl. XIII, fig. 2), only *H. pallidipennis*, *T. gratus* and *T. pertineus* were seen.

(*g*) Kateri.

Prior to my visit to Northern Nigeria, reports had been received by the Principal Medical Officer, Dr. S. W. Thompstone, C.M.G., that sleeping sickness was very prevalent in and around Kateri in the Zaria Province—a very inaccessible region seldom visited by Europeans. At the request of Dr. Thompstone, I visited this district in December. A start was made from Kugo on the Baro-Kano Railway on November 29th; Kateri was reached on December 1st; two

days were spent in this vicinity, and the return journey was made, by a different route, to Kogin Sirikin Pawa (also on the railway), which was reached on December 7th—the total distance covered being about ninety-seven miles.

This part of the country is very imperfectly known, and several of the towns mentioned here are not given on any map, but their approximate position may be gauged from the text of the report and the route shown on the appended map. The first day's journey brought us to Wuye, a distance estimated at about nine miles, but very difficult trekking owing to the extremely hilly and rocky nature of the country. The route was very sinuous, and numerous streams were crossed. The vegetation as a whole was fairly open, but a few dense kurimi-like patches were traversed. No blood-sucking flies, however, were seen during the journey. Wuye is a small Gwari town on the top of an extremely steep hill, and it is noteworthy that the majority of the Gwari towns are so situated for purposes of defence: thus the probability of *Glossina* occurring in them is very remote. At and around this town the following species of Tabanids were caught, *Haematopota decora*, *H. pallidipennis* and two species of *Tabanus*, both probably new.

The next town at which we camped was Doka (shown on the map), distant about seventeen miles. The first part of the road is very rocky and similar to that between Kugo and Wuye, but mostly down-hill. When that part is passed, the road is good, and there is abundant low scrub and long grass. A tributary of the Kogin Sirikin Pawa had to be crossed, and later that river itself. Several kurimis were passed through, and, although there is dense vegetation along the banks of both the streams mentioned, and all seemed likely haunts for tsetse, none was seen: the only blood-sucking flies caught being *Haematopota pallidipennis*, and one specimen of the new *Tabanus* obtained at Wuye.

Doka is a Kadara town of moderate size situated on the edge of an extensive kurimi. The camp was pitched in a clearing in this kurimi, the vegetation of which was so dense that the sun's rays hardly penetrated and the air was damp and musty. Numerous *Glossina palpalis* occur at all parts of the kurimi and in the town itself.

From Doka to Kateri is roughly about eighteen miles. The country is covered with open bush, but this is intersected in every direction, at varying intervals, by long stretches of dense bush. In several of these *G. palpalis* was seen, and doubtless occurs in all. At the River Dinia, which was crossed on this march, *G. palpalis* is also abundant.

Kateri is a Kadara town situated in a small open clearing in the centre of a dense kurimi, which extends for several hundred yards all round, while radiating from it are several moderately wide strips of bush of a similar nature (Pl. XIV, figs. 1 and 2). The Kadaras are a very primitive and shy people; the women are absolutely devoid of clothing, and the children are supported on their backs by skins, chiefly those of a species of monkey and the harnessed antelope. The importance of this fact is seen when one remembers that the women are the water-carriers, and that the water-pools stand in thick bush swarming with tsetse, so that they have no protection from the attacks of these insects. One case of sleeping sickness was found in this village, and though there was no evidence of

anything approaching what might be termed an epidemic, either at present or in the past, still the importance of the existence of such a focus is a serious menace to non-immunes, such as Europeans, who may come within range of it. The blood-sucking flies caught in and around the town were *G. palpalis* (in great abundance), *Haematopota pallidipennis*, *Tabanus sp.* (near *gratus*), *T. pertinens*, and two species of mosquitos. Trypanosomiasis in horses is responsible for a heavy annually mortality in this region, but this disease the natives attribute to two plants, one a species of *Pandanus*, and the other a liana-like leguminous creeper, which are supposed to contaminate or poison the drinking water.

Just outside the kurimi in which the town is situated is a large area of open ground, covered with long grass and thin bush or isolated trees, similar to that shown on page 328. There we camped, at a distance of about 150 yards from the kurimi, and only an occasional tsetse was seen, these having followed the women bringing water and firewood to the camp, although within the kurimi itself they swarmed around one constantly.

In view of all these facts:—(1) the position of the town in the centre of a kurimi, (2) the prevalence of sleeping sickness, (3) the abundance of *Glossina palpalis*, and (4) the existence of a large area of open ground in the immediate vicinity—some measures ought to be adopted to minimise the risks attendant on such a focus of sleeping sickness. Every endeavour should be made to have the town removed into the open clearing and the area around it denuded of all bush. The presence of individuals with trypanosomiasis is of necessity a source of danger, as they serve as reservoirs and tend to increase the number of infective tsetse; it is highly desirable that all such cases should be at once removed to a segregation camp.

The return journey from Kateri was made by way of Kurimi-n-Iya, Kwakou, Kumbaku to Kogin Sirikin Pawa. The road from Kateri to Kurimi-n-Iya passes through the two small Kadara villages of Bini and Adana. The vegetation may be described as thin open bush, intersected by a succession of kurimis. Less than 500 yards from Kurimi-n-Iya, a small river was crossed, and there *Glossina palpalis* was caught. The town itself is situated in a kurimi, as the name would suggest, and swarms with *G. palpalis* (Pl. XV, figs. 1 and 2). It was impossible to find near this town a piece of open ground suitable for a camp which would be a safe retreat from tsetse, and we had consequently to camp between two dense kurimis. Both *G. palpalis* and *G. tachinoides* were caught in the camp, and the tents were invaded by swarms of *Haematopota pallidipennis*, forty of this species being captured between 2 and 3 p.m.

About six miles from Kurimi-n-Iya is situated the town of Bichi, a very flourishing place, extensively cultivated. Three miles further on is the village of Goda, while Kwakou is distant about six miles from the latter. This route passes through several kurimis and numerous extensive "fadamas" or swamps, which would be practically impassable in the wet season. It is very rocky in places, and the grass in the marshes is between eight and nine feet high. *G. palpalis* was seen in a kurimi between Goda and Kwakou, and also at the latter place.

Kumbaku is about twelve miles from Kwakou. Immediately after leaving Kwakou, the river Dinia is crossed, and from this the road is practically level.

and passes through open bush country, beyond which is a range of hills composed of a large number of huge granitic bosses. Between two of these is a narrow sinuous pass, in which is the Hausa town of Kumbaku. In this valley there is a deep narrow ravine, in which runs a small stream which contains water during the whole year. Near it were caught the following blood-sucking flies:—*Glossina palpalis*, *Stomoxys calcitrans*, *Haematopota pallidipennis*, *Tabanus pertinens*, and another species of *Tabanus* similar to those already mentioned.

The road from Kumbaku to Kogin Sirikin Pawa is very hilly and rocky for about the first ten miles, after which point there is a sudden descent into the valley of the river of this name. Onwards, for about five miles, the country is covered with thin open bush. No biting flies were seen during this trek, but at the river itself *Chrysops distinctipennis* and *Haematopota decora* were caught around the horses and cattle crossing the ford.

A few outstanding features in connection with this trip call for comment. Geographically, the route may be considered thus. Leaving the valley of the Kogin Sirikin Pawa, we crossed the watershed separating this river from the River Dinia; the valley of the Dinia was then traversed until at Kateri one reached the watershed separating the Dinia from the Garara River, a tributary of which, the Mahabei, runs southwards from Kateri. The return route followed the valley of the Dinia River, and then crossed the watershed into the valley of the Kogin Sirikin Pawa. Kateri, therefore, standing between the Rivers Dinia and Garara, is subject to the influences of both, at any rate in so far as its *Glossina* supply is concerned.

The whole of this part of the country may be described as kurimi-bearing, and it may safely be said that where the country has this character strongly accentuated, *G. palpalis* will be found. *G. tachinoides* was caught at only one place, namely, Kurimi-n-Iya, while *Haematopota pallidipennis* occurs throughout this whole region.

Sleeping sickness was found at Kateri, but doubtless occurs in other villages in similar situations. The removal of such villages to open ground and the clearing of the dense bush which surrounds the wells, is strongly to be recommended.

(*h*) Minna to Izon.

In order to make as complete a survey as possible of the Garara River, I first proposed to continue southwards from Kateri, but owing to the unsettled condition of this part of the country, on the advice of the Resident, I returned to Minna by rail, and following the main Abuja road, struck the Garara River at Izon. This road passes through Paiko, Shaku and Tufa.*

The first part of the journey is through gently undulating country and thick bush. About half-way to Paiko, the Bako River has to be crossed. This river was very low in December, but in the height of the rains is about 50 yards wide,

* Neither Shaku nor Tufa is shown on the map, but a study of the text will give their approximate position.

and a canoe has to be used. *Haematopota decora* and *H. pallidipennis* were caught hovering around the pony, while one tick was also found on him. Around the town of Paiko, which stands at the base of a commanding hill, is an extensive fertile plain, where the Fulani graze large herds of cattle. No biting flies were seen, nor are there likely to be any in this district, owing to the almost complete absence of any form of shade. The fact that cattle live well in this vicinity and that horses are bred here also points to the absence of tsetse or other biting flies.

About five miles beyond Paiko, there is a small river, where *G. palpalis* occurred in swarms; while again before Shaku, the river Jatto or Ebba has to be crossed. At the latter river only *Haematopota pallidipennis* was found. Shaku is a small town at the base of a large hill. No cattle are kept here, but a few mares were seen. The chief, however, complained of a sickness which killed off the horses, and his description of the disease was extremely suggestive of trypanosomiasis. The only blood-sucking flies caught or seen were *H. decora*, *H. pallidipennis* and *Tabanus sp.*

About eleven or twelve miles from Shaku is the village of Tufa, a beautiful small Gwari town situated on the edge of a kurimi. The road for the greater part of the way is through open orchard-like country and high grass. It is not at all improbable that *G. palpalis* occurs at Tufa, though none was seen.

From Tufa to Izon is about six or seven miles. The road passes through long grass and several fadamas. There are small hills on all sides, but the road itself runs through a plain, and in the dry season is fairly good. Outside Izon there are numerous large farms with rice, millet, guinea-corn, beans, cotton, etc. The town of Izon consists of several small sub-villages, and is a very important centre for agricultural produce; it is situated in the Nassarawa Province, on the left bank of the river Garara. The river at this part is from three to six feet deep in the dry season, but over twenty in the rainy season; the banks are steep, and the width varies but little at the different times of the year, being always from forty to fifty yards. Crossing is effected in canoes. It is a slow-flowing stream, of which the bed and banks are composed of sand: the banks are covered with dense vegetation and high shady trees. At the crossing itself, which is sandy, *G. palpalis* is abundant, as also are *Tabanus gratus* and *H. pallidipennis*. Further removed from the river, *G. tachinoides*, *H. pallidipennis* and *T. pertinens* were caught, while in the town itself both *G. palpalis* and *G. tachinoides* were found; these last may, however, have followed the natives from the river crossing.

As has been already mentioned, this ford is on the main Zungeru-Abuja road, and is consequently very important. There is a continual stream of natives passing to and fro, and numbers may be seen at almost any hour of the day waiting to be transferred in the canoe. The clearing in the bush is a few yards in width, only sufficient for the canoe to be brought alongside for loading. High shady trees overhang, and tsetse swarm all around. A distance of at least fifty yards on each side of the actual crossing could, with little difficulty, be denuded of all bush and shade-trees. The same ought certainly to be done at the crossings of the Bako river, the river near Paiko, and the river Jatto.

(*i*) The River Garara.

From Izon I followed the river Garara as closely as possible to its mouth, near the village of Derri. This part is very imperfectly known and mapped, and there is no direct route. Consequently I had to rely on native information at the various towns visited, and by careful questioning tried to include all the towns and villages situated on or near the river: a sketch map (Pl. XVI) is given to show the route followed. To enter into the full details of this trip would occupy more space than is available at present: so I shall content myself with giving in broad outline the most noteworthy features pertinent to the investigation in hand. On this journey I was accompanied by Dr. J. W. S. Macfie.

The river was crossed at a point about two miles south of Izon, near the village of Chini, and although it was only 6.30 a.m. *G. palpalis* was caught. The bank of the river is everywhere covered with dense shady bush overhanging the water. From this point, the route diverged considerably from the river in the direction of Lapai. The first day's halt was made at the village of Gau, an almost impregnable mountain fortress, accessible only after a very arduous climb, and ensconced on a small plateau surrounded by enormous granite boulders. No biting flies were seen here, nor would one expect any. Horses bred in this town showed no evidence of trypanosomiasis, nor did natives complain of any high mortality or give any history of a disease which at all resembled trypanosomiasis. According to the Siriki (or headman), sleeping sickness was unknown here.

The descent from Gau is more gradual towards Lapai: the road skirts the base of a hill and passes through fairly open country. About a quarter of a mile from Lapai, there is a small stream where the natives obtain their water, and here both *G. palpalis* and *G. tachinoides* were caught. The town of Lapai stands on a rocky hill and is surrounded by an extensive plain, on which there are large herds of Fulani cattle. These, as well as horses, seem to thrive quite well.

From Lapai, we were again able to strike the Garara at the village of Dagu, and from this point the road runs practically parallel with the river the whole way to Derri. The country between Lapai and Dagu is hilly and the path is very rocky in places. The village of Dagu stands in dense bush and there both *G. palpalis* and *G. tachinoides* invaded the tent in considerable numbers.

From Dagu we proceeded to Wopa, a small town in kurimi-country, having passed through several small villages (Chakun, Kuka, Nimbo Gwari and Yelwa). No tsetse were seen here, but they may exist, at any rate in the wet season. After Wopa the next important town we touched at was Guredi. This part of the road is good and the surrounding country is covered with thin open bush.

Through the kindness of the Resident at Lapai, the Emir of that district sent a mounted messenger to accompany us to Derri. When we reached the town of Guredi, however, the latter strongly advised us not to attempt to take ponies further, as he assured us they would certainly die on the way. He supported his opinion by sending his own pony back to Lapai, and walking the remainder of the journey. This was certainly strong proof that he was convinced that ponies could not live in this region, owing, according to him, to the poisonous nature of the drinking water. He cited a case, which I have every reason to believe was

true, as it was several times corroborated, to the effect that when the Emir of Lapai, with nearly a hundred mounted attendants, visited this region, either during the trip or immediately after returning to Lapai, every single horse died, in all probability from trypanosomiasis. We continued to administer large doses of mercury and arsenic daily to our ponies; and much to the messenger's surprise and, to some extent, dismay, they arrived in Derri in good condition, showing no symptoms whatever of infection.

From Guredi the road passes through numerous kurimis to the village of Zago, where *G. palpalis* was seen around the ponies. The next village examined was Adagba, and between it and Lafian Yabba the River Uri, a small stream running through a kurimi, was crossed. Here also *G. palpalis* occurs. After Lafian Yabba, the road crosses a deep ravine by a small bridge. It being impossible to take the ponies over this bridge, a detour had to be made through a pestilential swamp of a very treacherous nature, in which the water, of a tomato-soup colour and consistency, in numerous places was over three feet deep. This part would be absolutely impassable in the rains. While leading the ponies through this region we saw numerous tsetse, but for obvious reasons none were caught. At the town of Yabba, *G. palpalis* was obtained.

The trek from Yabba to Mama (near Eki) was a very important one, inasmuch as three species of *Glossina* were caught. From Yabba to Chapa the country is very hilly, and there are numerous laterite outcrops, but onwards to Eji (also parallel with the river) the road is more level but very rocky. At Wada and Eji, *G. palpalis* was caught. From this point the road diverges from the river bank in the direction of Edzu.* Shortly after we had left the riverside, *G. tachinoides* was captured in more open country, while further on *G. longipalpis* was found (*cf.* the conditions obtaining at Baro, p. 329). At the town of Mama, *G. palpalis* again occurred, while here also were obtained several specimens of *Mansonioides uniformis* in the bush around the village.

The next halt was made at the town of Evua. The country is much more open, and both *G. tachinoides* and *G. longipalpis* were caught, while near Evua itself, which stands practically on the river, *G. palpalis* was obtained. Between Evua and Derri are situated the villages of Egba and Gerinya. The road from Evua to Egba passes over high hills and through deep steep-sided ravines. Some of these are very rocky and nearly 600 feet in depth, and are all but impassable for ponies. Before Egba can be reached, about two miles of open plain with an extensive marsh has to be traversed. The town of Egba stands in the centre of this marsh, and is a very important market-place. It is on one of the main Kano-Lokoja trade routes, and produce is brought here from Derri, Baro, Lapai, etc. The road from Egba to Derri is practically level; first it passes through a kurimi alongside a large lake, which is probably a backwater in the wet season; then towards the Garara it skirts the end of the range of hills already mentioned, and meets the river at Gerinya. This town is on the main route to Kotonkerifi, and from it the road runs along the bank of the Garara to Derri. In the kurimi referred to, *G. palpalis* was caught. At this part the river is wide, shallow and slow-running, and several sandbanks appear in the dry season. The sandy banks are covered with long grass and only occasional clusters of

* Mis-spelt Edza on the map.

bush. At this part of the river *G. tachinoides* are fairly abundant, but no *G. palpalis* were seen; this is due, no doubt, to the nature of the vegetation. The town of Derri is situated at the confluence of the Garara and the Niger. In the dry season it stands high and dry, and is surrounded by marshes and pools left by the falling river, but in the wet season it is an island on which water rises to the floors of the houses. In every respect it resembles Mureji at the confluence of the Kaduna and the Niger (Pl. IX, fig. 2). The following mosquitos were obtained during my stay at this town :—*Culex invidiosus*, *Myzomyia funesta*, *Mansonioides uniformis*, *Banksinella luteolateralis* and *Ludlowia mimomyiaformis*.

It might be well to summarise briefly a few of the outstanding results of this trip :—

(1.) The journey was made at the height of the dry season—from December 17th to December 25th.

(2.) The banks of the River Garara, wherever seen, were covered with dense vegetation, and numerous kurimis occur everywhere in the vicinity of the river. In such situations *G. palpalis* was almost invariably found.

(3.) The only other species of tsetse seen were *G. tachinoides* and *G. longipalpis*. The former was found at Dagu, near Wada, Evua, and between Gerinya and Derri. In all these places the bush was open and removed some distance from the river. *G. longipalpis* was caught at Evua, and between Wada and Edzu, in both cases in open country and still further removed from water.

(4.) No TABANIDAE were seen during the trip.

(5.) Mosquitos : *Mansonioides uniformis* was caught at both Mama and Derri; while at the latter town *Culex invidiosus*, *Myzomyia funesta*, *Banksinella luteolateralis* and *Ludlowia mimomyiaformis* were also obtained.

(6.) Ticks were seen only at Mama.

(7.) The whole region along the Garara has a bad reputation for horses, so that none are kept in the vicinity of the river, every attempt having met with failure.

(8.) At towns more remote, such as Lapai and those situated on high ground, *e.g.*, Gau, horses and cattle are kept with impunity.

(*j*) Derri to Bagana.

Having thus completed the examination of the Garara River, I decided to visit the Province of Bassa, as sleeping sickness had been reported from this region, and little or nothing had been done from an entomological standpoint. For this purpose, it was necessary to go to Bagana on the south bank of the Benue River. The journey was made in three stages : (1) to Kotonkerifi on the Niger, by canoe; (2) Kotonkerifi to Umaisha, by road; and (3) Umaisha to Bagana, by canoe.

The trip from Derri to Kotonkerifi occupies only about five hours, and is accomplished in native dug-out canoes. The river bank is mostly overgrown by dense shade-trees, but there are numerous sand-banks, which are partially covered with long xerophilous grass. Only one tsetse was seen, apparently *G. tachinoides*. Numerous crocodiles were observed basking on the sand-banks. The native town of Kotonkerifi is about three miles distant from the point of disembarking,

and is separated from it by a dense kurimi, more than a mile in breadth. In this kurimi there are numerous pools of considerable size. At the height of the rains, it is more than probable that these connect with the Niger.

The town is moderately large and is an important market-place for the surrounding district. Five hundred people were examined for sleeping sickness, but no case was found. Cattle are bred there, and seem to thrive quite well, but horses have been brought at different times from Keffi and Abuja, and, according to reports by the natives, all have died within a few weeks of their arrival. Seven horses died thus during one season. The interpreter, kindly lent to me by Major Blakeney, the Resident at Keffi, informed me that on one occasion Major Blakeney, while on trek, brought two horses to Kotonkerifi both of which died of trypanosomiasis on their return to Keffi, although they were to all appearance perfectly sound before setting out. The natives there, as elsewhere, attribute this to the drinking water. The country around Kotonkerifi is covered with dense bush and abundant undergrowth. This is intersected by numerous backwaters from the Niger, and at the time of my visit (December), there was a large number of pools isolated by the falling river. *Glossina palpalis* and *G. tachinoides* were everywhere abundant.

The road from Kotonkerifi to Umaisha, which are both in Nassarawa Province, passes through numerous towns, none of which are indicated on the small scale map, and as most of them are not shown on the larger scale map, it has been considered advisable to include them here so as to make the individual records more precise. Their relative position may be gauged by the *Glossina*-localities shown, in order, on the accompanying map.

The country between Kotonkerifi and Ikpariki is covered with high grass and thin low bush, and is eminently suitable for *G. submorsitans*. Between Ikpariki and Ibefu, there is a large amount of cultivated land, and the bush is therefore considerably reduced in amount. After Ibefu the road is very stony and hilly owing to a rocky outcrop, but towards Denjiri it again becomes level, and everywhere there are extensive farms of yams and guinea-corn. At Denjiri, both *G. palpalis* and *G. tachinoides* were caught.

According to the natives, a short time after horses are brought to this region, they show marked oedema of the legs, belly and scrotum, micturate in small quantities, lose their appetite, and finally die in five to eight days. This is clearly indicative of trypanosomiasis, but although *G. submorsitans* was specially sought for in likely places, none was seen.

From Denjiri to Ogusu the road passes through numerous kurimis, between which are extensive farms. About half-way is the town of Utu and here *G. palpalis* occurs. Ogusu is simply a collection of scattered farm hamlets; *G. tachinoides* was the only blood-sucking insect obtained in this region.

The country from Ogusu to Umaisha is fairly open and extensively farmed. In and around the town of Umaisha, which is practically on the banks of the River Benue, both *G. palpalis* and *G. tachinoides* were obtained. The siriki (or local chief) complained bitterly of the loss of horses from a disease which he called "chiwon aguna" (or swelling sickness), and which is almost certainly trypanosomiasis, but no *G. submorsitans* were seen. As elsewhere, this disease is attributed to the drinking-water.

From Umaisha, on the left bank of the River Benue, to Bagana, about 40 miles further up, on the right bank, the journey was made in native canoes (Pl. XIV, fig. 1). The banks of the river are covered for the most part with thick dense bush overhanging the water, but at several places where they are composed entirely of sand, only xerophytic grass is seen. At the time of my visit (December 31st), the river was practically at its lowest level and was studded with numerous sand-banks, which bore no vegetation and which would be under water several feet in depth in the wet season (Pl. XII, fig. 1). On these, the natives passing up or down the river make temporary encampments, and at one of them we saw a horse which was suffering badly from trypanosomiasis. A specimen of *Tabanus taeniola* was obtained feeding on this pony.

Poling up-river in canoes being extremely slow, it was found necessary to camp on one of these sand-banks near Amara. A strong harmattan was blowing throughout the day, and in the evening there was a heavy drenching mist, which persisted through the night and until about 8 a.m. In spite of this, however, thousands of small flies, no doubt attracted by the lights, swarmed from the neighbouring banks and helped to make things even more uncomfortable. The next day (January 1st) we arrived at Bagana. *G. palpalis* was caught halfway between Amara and Amageddi, and also at Amageddi. Crocodiles abound on all the sand-banks, and one hippopotamus was seen near Amageddi. A new species of *Tabanus*, near *T. africanus*, was obtained by Dr. Foy at Amageddi and is described above by Mr. E. E. Austen under the name of *Tabanus necopinus* (p. 279).

(*k*) Bassa Province.

This province is one of the most southerly in Northern Nigeria. It is bounded on the north by the Benue River, on the west by the Niger, on the south by Southern Nigeria, and on the east by the Muri Province. The capital is Ankpa, and from it there are two main routes, one to Bagana on the Benue, and the other to Ghebe on the Niger, opposite Lokoja. For my purpose I considered it advisable to make a start at Bagana, proceed to Ankpa, and thence to Ghebe, thus traversing the province from Ankpa towards both rivers.

The town of Bagana, in addition to its being the Benue port for the province, is also an important trading centre, and consists of about 400 huts. It stands close to the river bank, which is densely covered with thick vegetation. Not far from the town, a small stream enters the Benue, and there *G. palpalis* and *G. tachinoides* swarm in large numbers, while along the banks of the Benue itself the same two species were everywhere found. One case of advanced sleeping sickness was seen here, and this emphasises the danger of having in the vicinity of the town and of the European factory thick bush which harbours large numbers of *G. palpalis*, even in the height of the dry season. Mortality amongst horses is very high; one agent of the Niger Company lost three from trypanosomasis in one year. No *Glossina submorsitans* were seen.

Bagana to Ankpa.

The road from Bagana to Abajikoro[1] passes through several small villages, over three small streams, and one moderately large river, the Amara. Up to

[1] Shown on the map as Abajikolo.

Giddan Idrezu the country is open, with a few large trees, numerous clusters of dwarf shrubs, and abundant high grass. The village of Barkumi is on the bank of a small stream, while the town of Igaudum stands on another, the Uge. The latter is crossed by means of a large fallen tree and is surrounded by a dense kurimi and here *G. palpalis* occurs in large numbers. The River Amara is spanned by a bridge about 60 feet in length, which is situated in thick bush, where *G. palpalis* was seen. The town of Abajikoro also stands on a small stream, the banks of which are overhung with dense bush as in the case of the others ; there also *G. palpalis* swarmed. No horses are ever kept in this locality, except a few in transit to Ankpa. The natives state that any horse brought to one of these villages would certainly die within a few months.

The town of Akwacha is about 15 miles due south of Abajikoro. Shortly after leaving the latter town the road crosses the River Amara, while towards Akwacha are two other small streams, probably tributaries of the Akwacha River, which runs into the River Amara, and this in its turn, flows into the Benue. All these streams are fringed by dense forest growth which more than probably harbours *G. palpalis*, although only at a small river half a mile from Akwacha were specimens actually caught. The village of Egga stands in a thick kurimi near this river, and at the watering place of this town, *G. palpalis* was seen. Akwacha is a large town on the bank of a river of the same name ; there also *G. palpalis* were taken in numbers, while even at the rest-house, more than half a mile from the town, and in an open clearing, one specimen was caught biting the writer at 5.30 p.m.

The people inhabiting this region are known as Igbaras, but there are also numerous Hausa trading settlements. The Siriki, or headman, of Akwacha being extremely intelligent, an attempt was made to verify and add to the names of flies previously obtained at the various villages. This tribe does not seem to differentiate between the various types of biting flies, as do some of the others. Any fly which bites they term "unu," but beyond that the only distinction they draw is with regard to the animal attacked, for example, "unuanya" is the fly which bites the horse (anya=horse), while "unuefa" denotes any fly which bites the "efa," or "bush cow." On being shown large Tabanids, small Tabanids and tsetse, the Igaras used any of these three terms to denote one and all of them indiscriminately. They, however, distinguish mosquitos under the name "imu." Sleeping sickness they term "ogaulu" (oga=sickness, ulu=sleep), while enlarged cervical glands they style "atalahu." No horses are kept at Akwacha owing to the high rate of mortality

Immediately outside Akwacha three deep ravines have to be crossed. These were practically dry in January, but in the wet season they hold streams of considerable depth. Beyond these is the village of Uriwa, and a little further on a fairly large river, the Urito, has to be crossed. The nature of the country up to this point may be described as thin open bush, but beyond the Urito there is an extensive kurimi, which stretches for nearly four miles to the town of Auru. This is probably the densest kurimi seen during my tour in Northern Nigeria. Apart from the main road, which runs through it, it is practically impenetrable

without the use of axes and matchets. On entering it one is conscious of a fall of several degrees in the temperature, and except in a few places the sun's rays hardly penetrate, so that the shade afforded renders the use of a helmet almost unnecessary. It was a veritable haunt of tsetse, which simply swarmed around the ponies and carriers, and were extremely persistent in their attacks, but at the same time very wary and difficult to catch. Both *G. palpalis* and *G. longipalpis* occur there. One of these, a *G. longipalpalis*, was observed on the pony's neck after it had been feeding for some time. On being disturbed, it fell to the ground less than a yard away, and so gorged with blood was it that it could not cross its wings, nor was it able to fly. Although only about three feet away from the bush, which it endeavoured to reach, it managed to cover this distance only after four abortive attempts to fly, which resulted only in a series of long jumps. After entering the bush, it settled on the under side of a leaf, and remained there for some ten minutes, during which time I watched it and then without any difficulty caught it by means of its wings. It hardly made any effort to escape, but sat on my hand in a comatose condition.

At the town of Auru, *G. palpalis* was caught, and the same species was found at Oda. The road from Auru to Oda is excellent, and passes through open bush country. Near the town of Oda, two specimens of *Chrysops silacea* were secured. From Oda to Ankpa there are numerous long stretches of dense bush, but, although tsetse no doubt exist all along the road, none was actually seen on this journey. The latter town has lately been made the headquarters of the province. The European settlement is situated on the side of a steep hill leading down to the valley of the River Mabolo, but the site has been condemned by Dr. M. Cameron Blair, the Senior Sanitary Officer for Northern Nigeria. During the rains, the water coursing down the hillside practically floods all the houses, and drains several feet deep are hardly sufficient to carry it off. The military quarters at the foot of the hill, and the parade ground are frequently under water during this season.

The rivers and streams which have been hitherto mentioned in this province all drain into the Benue, but the Mabolo in the Ankpa valley runs into the River Anambra, which is a tributary of the Niger, and enters it near Onitsha, in Southern Nigeria.

The bed of the Mabolo is composed in this region of beautiful white sand, and the river itself is surrounded by dense kurimi. *G. palpalis* is everywhere abundant, and specimens were seen in the European military quarters, and also in the house in which I was stationed, about half-way up the hill. Apart therefore from the question of flooding during the rains, the site of the European quarters at Ankpa must be condemned owing to its too close proximity to the *palpalis*-bearing kurimi in the Mabolo valley. A new site has been selected on the high plateau, and although there is a certain amount of clearing already accomplished in this part, considerably more will have to be done in order to minimise the possibility of *G. palpalis* actually invading the European enclosure.

Trypanosomiasis in horses is extremely prevalent at Ankpa. Seldom do any live for more than three or four months after their arrival. One medical officer who was stationed here kept a horse alive for seven months,

but this constituted a record. Two political officers arrived at Ankpa several days before my visit. They left Lokoja, each having a pony, on the 25th of December. These ponies were examined at Lokoja before leaving, and were pronounced as evidently free from trypanosomiasis; yet within ten days of their arrival in Bassa Province both showed distinct symptoms of this disease. The only part of the Province traversed during this time was the main road from Ghebe to Ankpa. One of them had been sent away before my visit to Ankpa, but, on January 7th, the blood of the other was found to be swarming with trypanosomes. Through the kindness of the owner (Mr. Smith), this pony was lent to me for my interpreter, who was unable to walk, and it accompanied me to Ghebe. Prior to this, nothing had been done in the way of treatment, but during the journey to Ghebe it received full doses of arsenic and mercury daily. Owing, perhaps, to the advanced stage of the disease, the animal showed no signs of improvement, but rather the reverse, and although I was unable to follow up the case I am of the opinion that it also fell a victim to trypanosomiasis in Bassa.

It may be worthy of note here that my own pony, which accompanied me from the middle of November throughout my tour to Kateri, down the Garara River and through Bassa, and which was dosed three times a day with mercury and arsenic, showed no trace of trypanosomiasis when I sent him back to Zungeru from Lokoja in the middle of January.

Ankpa to Ghebe.

The distance from Ankpa to Lafia is about twenty-one miles. The road runs through very thick bush practically the whole way. At Amakutu, about nine miles from Ankpa, there is a small stream, and there *G. palpalis* occurs. From Amakutu to Lafia no water is crossed until about a mile from the rest-house, where a stream of considerable size, the Okura, about 40 yards wide and 2 feet deep in the dry season, flows to the Anambra. The town of Lafia practically commences here, and is scattered in groups of about a dozen huts over an area of more than 2 miles in diameter. The bed of the river Okura is very sandy, and the road for over half a mile from the ford is composed of very fine sand. The rest-house is situated on the edge of a kurimi, where there is a ford, and where the natives wash and obtain their water. One *G. palpalis* was caught at 7.30 a.m. in the rest-house, a distance of 100 yards from the kurimi. It would be well when this camp has to be rebuilt if it were removed some considerable distance further from the kurimi. I spent several hours at the ford of the River Okura, a tributary of the Anambra, in the kurimi where there was a continuous procession of women coming and going, and at all times *G. palpalis* and *Chrysops silacea* were abundant. The bush was very high and dense and the sun's rays hardly penetrated to the watering place. When no women were actually at the water, the majority of the tsetse retreated to the bush, and only an isolated specimen or two could be seen, but as soon as any women came to draw water they were immediately attacked. Never did I see any woman come and go without a tsetse alighting on her. This part of the native women's work consequently renders them much more liable to infection by tsetse than is the case with the men, whose duties keep them more on the farms and further from tsetse-haunts.

The country from Lafia to Ogumi, a distance of about 12 miles, is covered with moderately thick bush which in a few places resembles the kurimi type of growth. No streams are crossed on this trek. For about half-way, the River Okura runs practically parallel with the road at about 300–400 yards from it. About 3 miles from the town of Ogumi in a kurimi, where the natives obtain their water, several *G. palpalis* were caught in the afternoon. From Ogumi to Aiyangba, the road passes through the same type of country as that described between Lafia and Ogumi, but there are more kurimis.

The town of Aiyangba is large but scattered, as is the case in nearly all the towns in Bassa: it stands near the top of a slight elevation. The natives obtain their water from a pool in a very dense kurimi some two miles distant from the town. There is no running stream, but the pool, which must have its origin in a spring, contains water more than sufficient for the town throughout the whole of the dry season. The shade at this pool is very dense, and the temperature is several degrees lower than in the open. *G. palpalis* and *Chrysops silacea* swarm around the women drawing water: of the latter species forty were caught in one hour. The notes made with regard to the ford at Ogumi were still further emphasised at Aiyangba. One *G. palpalis* was caught in the rest-house at Aiyangba, and, as has been recommended for Lafia, this camp should be removed further from the kurimi towards the town. The only advantage of having it in its present position is the proximity of the water supply, but this must essentially be considered as secondary to the avoidance of tsetse.

After leaving Aiyangba no further water is seen until Dekina is reached. The first part of the road passes through dense bush immediately followed by a long stretch over a bare laterite outcrop, while towards Dekina the country is more park-like in character, and the road is very uneven and undulating. The bush around the river at Dekina is very similar to that at Aiyangba, but tsetse are not nearly so abundant. At the river itself, *G. palpalis* was found, and further removed, in the more open park-like country, *G. tachinoides* occurs. The town of Dekina contains three separate settlements, Hausa, Igbara and Bassa Como, comprising in all between 300 and 400 huts. It was the head-quarters of the province before Ankpa.

The country towards Taketti continues park-like or wooded, but there is a considerable amount of rocky ground. Two streams occur on this road, one at the village of Olowa about four miles from Dekina, and another at Ajebela, five miles further on. About two and a half miles from Taketti, there is a very steep sinuous rocky descent into the valley of the Niger, but the river itself is distant some fifteen miles. The town of Taketti stands on a stream of considerable size which is bridged. No tsetse or other biting flies were seen at any of the streams crossed on this journey.

The road from Taketti to Ghebe is good and passes through undulating park-like country, but not far from Ghebe a deep broad river, probably a creek from the Benue, with outlet into the Niger, has to be crossed by canoe. There is considerable cultivation around this region.

Ghebe is a large town of over 1,200 inhabitants, and from its situation, almost opposite Lokoja, with which there is considerable trade, is probably the most

important in the province. No tsetse were seen at Ghebe, but this is not surprising, as the bush is very thin. It is highly probable that they occur during wet season.

The foregoing notes on my journey through the Province of Bassa, embracing as it did about 140 miles, and covering the two main routes from Aukpa, the capital, to Bagana on the Benue in the north, and westward to Ghebe on the Niger, may serve to indicate the general types of country which occur in this province. The rivers and streams between Bagana and Aukpa run into the Benue system, while those between Aukpa and Ghebe drain directly into the Niger.

The only blood-sucking flies caught or seen were *Glossina palpalis*, *G. tachinoides*, *G. longipalpis* and *Chrysops silacea*. *C. silacea* was found at Oda, Lafia and Aiyangba; *G. tachinoides* at Bagana and Dekina; *G. longipalpis* only at Auru; while *Glossina palpalis* occurred at practically every stream or pool examined, where there was a dense growth of shady bush (*vide* Map). With regard to *G. longipalpis*, it may be noted that this species had previously been recorded from Akwacha by Dr. G. J. Pirie, who found them "in the denser bush patches along the small watercourses." He added "trypanosomiasis both of animals (horses and dogs) and of man exists at Akwacha, especially in the rainy season, from May to October." It is somewhat strange that he found this species "rather numerous," but caught no *G. palpalis*, whereas at the time of my visit *G. palpalis* was much more abundant, and also much more widely distributed.

In such a type of country as occurs in Bassa Province it is very difficult to indicate how the chances of attack from tsetse may be abolished or even diminished without involving enormous labour and expense. At the same time villages such as Egga, which are situated in the centre of a dense kurimi ought certainly to be removed into more open country; the fords on the main routes from Bagana and Ghebe might with great advantage be cleared of the surrounding bush; and the wells and streams where water is drawn for the villages ought to be cleared in a similar manner. Several of the rest-camps are too close to the neighbouring kurimis, and, when being rebuilt, should be moved further away. As these improvements could be carried out by the inhabitants of the province through the various headmen with very little trouble, some attempt should be made to have them effected. The European settlement at Aukpa is much too near the Mabolo kurimi and, even if for no other reason, ought to be removed to a site on higher ground, and separated from the surrounding bush by at least 200 yards of clearing.

Mention has been made of the enormous amount of trypanosomiasis which occurs, and the impossibility of keeping horses almost anywhere in this province. When it is remembered that the only three species of *Glossina* which have been found are *palpalis*, *tachinoides*, and *longipalpis*, and that the last-named is confined, so far as one can judge, to the Akwacha region, and that the only locality where *tachinoides* has been found away from the river Benue is Dekina, the question naturally arises:—What is the carrier? The evidence seems to point to *Glossina palpalis*, but even were this proved to be the case, the problem would not end there. The further question would arise:—Where does the infection

come from? When we take into consideration the small number of horses which are brought to this province annually, and the extremely short interval which elapses before these show symptoms of trypanosomiasis and die, we must conclude that, whatever be the carrier, the percentage infected must be large. It seems hardly possible that the infection could be carried, in the circumstances quoted, from horse to horse, but if this be so the infected insect must remain infective for a very long time. More probable, however, is the hypothesis that the insects become infective from some other source, such as game, but as this has been neither proved nor disproved it opens up a fruitful line of research.

V. RECORDS OF BLOOD-SUCKING INSECTS AND OTHER ARTHROPODS FROM NORTHERN NIGERIA.

The majority of the insects mentioned in the following list have already been referred to in the preceding pages, but it might be well to tabulate these for the sake of completeness. The table will also form a guide to any who may be interested in this work and serve to show what species may be expected, but it must be borne in mind that in all probability this list is very far from complete, especially as regards the more northerly parts of the Protectorate.

In the majority of the species the records are far too scanty to admit of any discussion of their distribution, so that I propose to leave this over until more data are forthcoming. I may also add that several new species from Northern Nigeria await description and these have not been included in the following list.

Order DIPTERA.

Family CULICIDAE.

Section **Anophelina.**

Anopheles wellcomei, Theo.
Myzomyia costalis, Loew.
„ *funesta*, Giles.
„ *umbrosa*, Theo.
„ *marshalli*, Theo.
„ *flavicosta*, Edw.

Myzorhynchus mauritianus, Gr.
„ *paludis*, Theo.
Nyssorhynchus maculipalpis, Giles.
„ *pharoensis*, Theo.
„ *squamosus*, Theo.
„ *watsoni*, Edw.

Section **Culicina.**

Aedomyia catasticta, Knab.
Banksinella luteolateralis, Theo.
Culex decens, Theo.
„ *duttoni*, Theo.
„ *fatigans*, Wied.
„ *grahami*, Theo.
„ *guiarti*, Blanch.
„ *invidiosus*, Theo.
„ *quasigelidus*, Theo.
„ *tigripes*, Gr. var. *fusca*, Theo.
„ *univittatus*, Theo.

Trichorhynchus (*Culiciomyia*) *nebulosus*, Theo.
Ludlowia mimomyiaformis, Newst.
Mansonioides uniformis, Theo.
Mucidus mucidus, Theo.
Reedomyia biannulata, Theo.
Stegomyia africana, Theo.
„ *fasciata*, Theo.
„ *gebeleinensis*, Theo.
„ *sugens*, Theo.
Taeniorhynchus cristatus, Theo.
Toxorhynchites brevipalpis, Theo.

Family Tabanidae.

Chrysops distinctipennis, Aust.
„ *silacea*, Aust.
Haematopota bullatifrons, Aust.
„ *cordigera*, ~~Aust.~~ Big.
„ *decora*, Walk.
„ *gracilis*, Aust.
„ *lucessens*, Aust.
„ *pallidipennis*, Aust.
„ *pertinens*, Aust.
„ *puniens*, Aust.
„ *tenuicrus*, Aust.
„ *vittata*, Loew.
Hippocentrum trimaculatum, Newst.
„ *versicolor*, Aust.
Pangonia ruppellii, Jaenn.
Rhinomyza stimulans, Aust.
Tabanus africanus, Gray
„ *albipalpus*, Walk.
„ *biguttatus croceus*, Surc.
Tabanus ditaeniatus, Macq.
„ *fasciatus*, Fabr.
„ „ var. *niloticus*, Aust.
„ *fuscipes*, Ric.
„ *gratus*, Loew.
„ *latipes*, Macq.
„ *laverani*, Surc.
„ *nyasae*, Ric.
„ *par*, Walk.
„ *pertinens*, Aust.
„ *pluto*, ~~Wied.~~ Walk
„ *ruficrus*, P. de B.
„ *secedens*, Walk.
„ *subangustus*, Ric.
„ *sufis*, Jaen.
„ *taeniola*, P. de B.
„ *thoracinus*, P. de B.
„ *williamsii*, Aust.

Family Muscidae.

Stomoxys brunnipes, Grünb.
„ *calcitrans*, L.
„ *inornata*, Grünb.
„ *nigra*, Macq.
Lyperosia minuta, Bezzi.
Glossina fusca, Walk.
„ *longipalpis*, Wied.
„ *palpalis*, R.-D.
„ *submorsitans*, Newst.
„ *tachinoides*, Westw.

Family Hippoboscidae.

Hippobosca camelina, Leach.
„ *francilloni*, Leach.
Hippobosca maculata, Leach.

Order SIPHONAPTERA.

Family Pulicidae.

Curtis *Ctenocephalus canis*, ~~Dugès~~.

Family Sarcopsyllidae.

Dermatophilus penetrans, L.

Order ACARI.

Family Ixodidae.

Amblyomma nuttalli, Dönitz.
„ *variegatum*, F.
Aponomma exornatum, Koch
Haemaphysalis leachi, Aud.
Hyalomma aegyptium, L.
Rhipicephalus appendiculatus, Neum.
„ *sanguineus*, Latr.
„ *simus*, Koch.
„ *falcatus*, Neum.

Family Argasidae.

Ornithodorus savignyi, Aud.

VI. NATIVE NAMES FOR INSECTS AND DISEASES CARRIED BY THEM.

The study of the native names of blood-sucking insects is fraught with many difficulties, as, more often than not, one name is used to include insects of very different groups, while again in some places different species have special names and these names do not always coincide.

So far as I was able to gather, the Hausa names are as follows:—

Mosquito = Soro.

Tsetse = Barabaji.

Small Tabanids (sometimes also Tsetse) = Gudanchiza (*i.e.* biting flies).

In Igara:—

Mosquito = Imu.

Any biting fly = Unu.

Large Tabanids = Unuefa (efa = bush cow).

According to Dr. J. M. Dalziel, the native names in the Sokoto Province, where he has spent a considerable time, are:—

"*Glossina spp.*, Tsande or Cheda (Zamfara).

Tabanus spp., Bobua or Kujen-giwa (generally the larger species such as *T. biguttatus*, but commonly used for any *Tabanus*).

Haematopota spp. (and *Chrysops*), recognised by the natives by their dappled wings, Kujen bauna or Sambaliko (Zamfara).

N.B.—The name Barabaji is correctly used only for *Hippobosca*, but is sometimes applied to practically every different species of biting fly, even the tiny *Lyperosia minuta*."

Just as in the Gambia,* most of the tribes in Northern Nigeria distinguish the *lethargic* stage of trypanosomiasis from the earlier stage, which is characterised by the presence of "bumps in the neck" or enlarged cervical glands, thus:—

Tribe.	"Bumps."	Sleeping Sickness.
Hausa	Chiwon wia (sick neck)...	Chiwon berichi.
Nupe	Patugi (patu = neck) ...	Bata elle.
Ikoto	Atogbe	Uku wara.
Igara	Atalahu	Oga ulu.

In the above names for sleeping sickness the first word in every case signifies "sick," and the second word "sleep."

Trypanosomiasis in horses is known at Umaisha by the name of Chiwon-aguna which is literally "sick-swelling."

VII.—THE GENUS GLOSSINA.

Five species of this genus have been found in Northern Nigeria, namely, *G. palpalis*, *G. tachinoides*, *G. longipalpis*, *G. fusca*† and one other which for the

* Bull. Ent. Res. II, pt. 3, p. 219.

† *G. fusca* has been recorded from Ife and between Poinia and Allu in Kabba Province, but none of these places have I been able to locate.

present must remain doubtful. Professor Newstead in a recent paper differentiated between *G. morsitans*, Westw., and *G. submorsitans*, Newst., on the strength of structural differences in the male genitalia, but further added that these two species could be distinguished by the abdominal markings, as follows :—*

In *G. submorsitans* "the transverse black abdominal bands are :—

(*a*) much more clearly and sharply defined ;

(*b*) equally and more narrowly interrupted in the median line on the third, fourth, and fifth segments ;

(*c*) slightly rounded medially and suddenly tapering towards the lateral margins.

"In *G. morsitans* the bands are :—

(*a*) not so sharply defined medially ;

(*b*) unequally interrupted in the middle line, the space between the two divisions of the band on the third being much greater than the space between those of the fifth segment ; and the dark colour gradually shading off into the pale colour forming the median line ;

(*c*) broadly rounded medially and very gradually tapering towards the lateral margins."

It is noteworthy that the types of this species were obtained at Katagum in Northern Nigeria, co-types in Northern Ashanti, and additional specimens in Ashanti and at Baro in Northern Nigeria. Numerous specimens from these localities are now in the possession of the Entomological Research Committee, but although a careful examination of these reveals that the majority of them undoubtedly present the abdominal markings ascribed to the species *submorsitans*, many also show the characteristic markings of *G. morsitans*, while all intermediate gradations may be found. The specimens in the National Collection in the British Museum from other West African Colonies also emphasise this point.

Consequently, it is not premature to say that, should this species be distinct, it cannot be separated from *G. morsitans* by these external characters, nor for the present are any others available. But, on the other hand, we may take account of the male genitalia, which must, as in other groups of insects, be regarded as characters of taxonomic importance.

Professor Newstead has separated these two species on the form of the "superior claspers," and the distinctions as shown by him, *provided they are found to be constant* and not linked up by intermediate forms, as in the case of the abdominal markings, certainly justify the establishment of distinct species.

In order to see if such a grouping were possible, I dissected the male genitalia of a large number of specimens from both West and East Africa, including specimens from the same localities as those examined by Newstead. This examination revealed the fact that it was possible to divide them into two distinct groups, and further, these groups corresponded with the geographical distribution ; in other words, the *submorsitans* type of genitalia (as defined by Newstead) was found only in the Nigerian, Gold Coast, Gambian, Senegambian and

* Bull. Ent. Res. II, pt. 1, p. 33.

Congolese specimens, and the *morsitans* type only in the East African specimens. It is quite possible that if a larger number be examined intermediate forms may be found, but in default of this, and for the reason given in a previous paper (*supra*, p. 297), I have decided to regard the Nigerian form as *submorsitans*, and as such they are recorded in this report and shown on the accompanying map. It may be, and probably is, the case that *G. submorsitans* is the western form of the eastern *G. morsitans*, just as *G. longipalpis* is the western form of the eastern *G. pallidipes*.

As already stated, all authentic records, including those in the National Collection, have been incorporated in the accompanying map, but several localities given on the labels attached to some of the specimens are so vague as to defy localisation by means of the published maps, and these are now added in the hope that those better acquainted with the districts mentioned may be able to furnish fuller information with regard to their precise position.

G. palpalis.—Kabba Province: Gbeliko, Oso, Akumbu, Ipesi, Obuni, Otun, Oshi R., Poinia, Ife, between Isua and Ifera, between Ibillo and Ate, Ekon, between Opepe and Edoka, between Opepe and Imiakebu; Bebua, Bade R., Bauchi Province, N. Nigeria 2000 ft.; Zugabutu, Nassarawa Province; Epa, Nupe Province; Glendenne; Zuguleba, Jega? District.

G. tachinoides.—Adiale, Bassa Province; Niger River between Yantalah and Borgu; Bebua, Bade River, Bauchi Province; Wolu R., near Siram; Ebuni, Kabba Province; half-mile S.E. of Alanjo, Hadeija; in swamp W. of Kugeru; Marama; Kabuk; Kontagora R., between Mudangi and Adala; Adala, Kontagora R.; Pakin, Kilenge R.; Nairanewa, Benue R.; Shari R. delta, Lake Chad; Goulfei on Shari R.; Shodu R.; Sokwa; Alo R., W. Marghi District, Bornu.

G. submorsitans.—Gwavo, Horin Province; half-mile S.E. of Alanjo, Haideija; swamp W. of Kugeru; Marama; Kabuk; Kontagora River, between Mudangi and Adala; Adala on the Kontagora River; near Daraja, Kontagora Province.

G. longipalpis.—Dokaro, Kabba Province.

I do not propose, in the present paper, to discuss the distribution of the various species of *Glossina* as I have already dealt, in chapters I and II, with the factors which influence such distribution; and further, because our knowledge of this subject is not yet complete enough for any generalisations. At the same time, I should like to point out a few of the outstanding deductions to be drawn from the present study.

(*a*) *G. palpalis* is confined to the Niger-Benue River system, and has not yet been found in the region of the Lake Chad system. This species also diminishes in numbers in the drier regions.

(*b*) *G. tachinoides* is found all over the Protectorate, but is more especially the predominant species in the north.

(*c*) *G. submorsitans* is also scattered all over the Protectorate, but is more intimately associated with *G. tachinoides* than with *G. palpalis*.

(*d*) *G. longipalpis* is essentially a Southern Nigerian form, and is found only in the provinces bordering that Colony.

(*e*) *G. fusca* is also a Southern Nigerian species, and so far has been seen only in the Kabba Province.

(*f*) In the various species of *Glossina*, as also in nearly all other species of insects, there is a gradual diminution in size and a gradual tendency to become paler in the northern parts of the Protectorate, where the country is more open, the dry season is of greater duration, and the influence of the dry hot harmattan is more intensive.

I hope to deal at greater length with the question of the distribution of the various species of *Glossina* as shown in this Protectorate, after my report on Southern Nigeria, when both Colonies may be regarded as one geographical unit. The same applies to the bionomics of tsetse and the other blood-sucking flies mentioned in this report.

I have added the following extracts from reports by medical officers in the Protectorate as these extend our knowledge of the distribution of *Glossina* in regions I was unable to visit.

Dr. J. M. Dalziel, reporting on a trip made in December, 1910, in the Sokoto Province with a view to "making inquiries in regard to the distribution and prevalence of tsetse in that neighbourhood," draws the following conclusions* :—

(1) On the main road between Anka and Banaga tsetse-flies are found at the following localities :—(*a*) Byassa, 15 miles south of Anka and 2 from Bajega—*G. morsitans ;* (*b*) In the three-mile belt of high woods beginning at 6 miles south of Bajega and ending at 3 miles north of Banaga—*G. morsitans ;* (*c*) Fassa, a tributary of the Banaga River, $2\frac{1}{2}$ miles north of Banaga—*G. morsitans* and *G. tachinoides ;* (*d*) Matakwri ravine near Daraga—*G. morsitans.*

(2) They are found in streams or in the bush away from the main road at :—(*a*) Korammar Beji, near Bajega—*G. morsitans* and *G. tachinoides ;* (*b*) Korammar Karawai, near Bajega—*G. morsitans* ; (*c*) west of Banaga, from the stream Fulani through the bush to Kainkenni, 4 miles from the town—*G. morsitans*, and in places *G. tachinoides.*

He adds, "No native admits that tsetse-flies are found north of Anka, 75 miles by road from Sokoto, and I think they are right" but some of the smaller TABANIDAE are found as far north as Sokoto.

Dr. C. W. McLeay, writing to the Principal Medical Officer (18.1.10), says with regard to the Ilorin Province :—

"*G. tachinoides* are plentiful on the Niger between Ogudu and Jebba—at Jebba itself *G. morsitans* is found. *Morsitans* occurs also at Ilorin and Pategi and a main belt crosses the Ilorin-Pategi road at Zambagu. At Orimope, Omu, Awtun and Osi *G. tachinoides* were caught by Asst. Resident Bryant. I think this fly must be very generally distributed over the southern portion of the Province and towards the Kabba country."

Capt. F. E. Bissell, R.A.M.C., writing from Bauchi on Dec. 7th, 1910, reports that he visited Bebua, altitude 2,200 ft., two days' march from Bauchi,

* Where possible, these records have been included on the accompanying map.

on November 30th, and in the vicinity of the stream which passes this town caught ten *G. tachinoides* and three *G. palpalis*. He further adds:—"If sleeping sickness did exist in Bebua it has disappeared now. Cattle trypanosomiasis does still exist to a certain extent. Bebua, for some reason which it is not easy to explain, is apparently an isolated patch of the district infested with *Glossina*."

VIII. PROTOZOAL DISEASES IN MAN AND OTHER ANIMALS.

Malaria.

As in the other West African Colonies, this is by far the most prevalent insect-borne disease in Northern Nigeria, but of recent years the number of cases has been gradually diminishing, owing in part to the extensive use of quinine as a prophylactic, and further to the measures adopted to effect a diminution in the number of mosquitos. The importance of the latter is now universally recognised, and much effective work has been done in this direction by the Medical Department. In order to strengthen its position in this matter, legislation is necessary, so that when once the sanitary officer has directed attention to any deficiency it should be made a punishable offence if this is not remedied within a reasonable time.

Yellow Fever.

So far as I could ascertain, no actual case of yellow fever has been reported from Northern Nigeria. But in view of the fact that it has recently been admitted that yellow fever is endemic in West Africa and has been reported from Southern Nigeria, and also that *Stegomyia fasciata* has been recorded from Lokoja, Baro, Geidam and Sokoto, in Northern Nigeria, stringent measures ought to be adopted to try if possible to exterminate this pest. It is now well known that this mosquito does not breed in large expanses of water or swamps but prefers small collections of water, such as one finds in tin cans and other small vessels. For this reason the disposal of the inevitable empty tins and such like is a matter for serious consideration, and it is to the individual houses and compounds that attention must be directed. Unfortunately in many cases the compounds around European bungalows are very often not free from such small receptacles. Some attempt should therefore be made to have these collected regularly and buried, and to aid the sanitary officer in this work it should be made a punishable offence to have any such receptacle lying within a compound, and that even in the dry season. The gutters on the bungalows retaining, as they do, the collected moisture from the evening dew on the roofs, when not carefully supervised, often hold sufficient water for *Stegomyia* to breed. These ought to be properly sloped and regularly cleaned so that such collections of water would be impossible.

It is unnecessary here to enter further into this matter as an instructive article by the late Sir Rubert Boyce on this subject has already appeared in this Bulletin.*

* Bull. Ent. Res. I, pt. 4, pp. 233-263.

Sleeping Sickness.

There can be little doubt that sleeping sickness is endemic in many parts of Northern Nigeria, but the actual delimitation of these areas is a very difficult matter. The occurrence of one or two cases in any village or town does not in itself justify the conclusion that that place is an endemic focus. For example, a case of sleeping sickness was discovered at Maiduguri, but after careful enquiry it was practically proved that the infection was obtained near Loko on the Benue. To regard Maiduguri, therefore, as a sleeping sickness area on this account would be erroneous and misleading.

Apart from this, however, one European died of sleeping sickness contracted either on the Garara River or in Bassa or Kabba Province, and cases have been recorded in persons who have never left their native district. Of course it is possible that the infection might have come from another locality, but in default of any definite information on this point we must regard these areas at any rate as suspected foci. These have been indicated on the appended map, and the following notes may serve to show how scanty our knowledge of this subject is, and also emphasise the necessity for an extended survey being organised to ascertain the precise distribution of the disease. When this is done it will in all probability be found that sleeping sickness exists in all the southern provinces and practically throughout the Niger-Benue river system. It has been reported from Sokoto and Katagum, but if cases did occur there it is probable that they were introduced. I have purposely excluded these from the map as the likelihood of these places being endemic foci is extremely remote.

According to the Medical Report for 1906 four cases, all natives, were recorded in that year, and the following note is added :—"Trypanosomiasis is fairly common in certain parts of the Protectorate. Most cases were found on the banks of the River Benue and in the Bassa Province."

In 1909 three cases were found in natives. "There is, however, considerable evidence to show that the disease is not uncommon on the Benue, but the portion of the Protectorate where it is said to occur has not yet been thoroughly examined. It is apparently confined to small areas and has never assumed the form of epidemics such as have occurred in East Africa."

Dr. J. W. S. Macfie who accompanied me during my trip in the Garara River district, says, "As the result of the examination of 952 persons in twenty-seven villages on the Garara River no case of trypanosomiasis was discovered. 7·1 per cent. of the people were found to have a slight enlargement of the cervical glands. From the statements of the headman at Izon, which is on the Nassarawa bank of the Garara, it would appear that sleeping sickness was once prevalent there but that it has completely disappeared in recent years. From the report of the Resident it would appear possible that sleeping sickness is not uncommon in Agaie but not in epidemic form. One of the cases detected at Baro last September (1910) was a man from Agaie."

With regard to the outbreak in Baro referred to, in which five cases were found, Drs. Ingram, Morrison and Macfie say :—"We are of opinion that the occurrence of trypanosomiasis is sporadic in Baro. There is, however, to judge from the prevalence of *Glossina palpalis* at this season of the year (August), no reason why it should not become epidemic." It must be remembered, however,

that Baro is the terminus of the Baro-Kano Railway, and that large numbers of natives from all parts of the Protectorate are congregated there in connection with the railway works. Consequently it is very difficult to say whether the infection was actually contracted at Baro or before these natives ever came to this town. One of the cases was from Agaie, another from Sierra Leone.

Sleeping sickness has been reported from Bebua about 30 miles from Bauchi, but Capt. Bissell, R.A.M.C., writing on a visit to that region in December 1910, says:—"If sleeping sickness did exist at Bebua it has now disappeared." As has already been mentioned, one case of human trypanosomiasis was found at Kateri, and in another part of this report certain recommendations have been suggested.

A segregation camp has been inaugurated near Zaria, and from the point of view of transport this region is satisfactory, provided suitable mosquito-proof vehicles be used in transferring infected cases, a precaution which was adopted in the case of those found at Baro. On the other hand it might have been better if a site could have been selected in the Lake Chad area, which, so far as can be ascertained, is a *palpalis*-free region. The number of known cases is at present, however, very small, and it is not necessary to conduct such a camp on a large scale, but should at any time an epidemic break out the question of establishing a camp near Maiduguri might be considered.

An ordinance ought certainly to be promulgated empowering the Resident on advice from the Medical Officer to have patients suffering from trypanosomiasis removed to the sleeping sickness camp.

It is more than probable that the natives of West Africa have acquired a high degree of immunity in regard to this disease, but this does not in any way justify less stringent measures being adopted. In fact the reverse is the case, inasmuch as immune natives *may* act as reservoirs and thus be a positive source of danger to the European population. For this reason every effort should be made to segregate the infected and to reduce the chances of transmission by judicious clearing in order to effect a diminution in the number of *Glossina palpalis* which, so far as is known, is the only carrier in West Africa.

Trypanosomiasis of Stock.

(*d*) Trypanosomiasis in horses and cattle is very prevalent, and this disease accounts annually for a heavy mortality. In this connection I would draw attention to the cases cited for Lokoja, Zungeru, the lower Gurara River and elsewhere in this report. In the case of Lokoja it is no exaggeration to say that sixty per cent. of the horses brought into the town develop trypanosomiasis within a year, and of these fifty per cent. die of this disease within the same period. Further, it is practically impossible to keep a horse in the Bassa Province for anything approaching a whole year.

There would appear to be two different forms of trypanosomiasis, with distinct clinical systems. I have found both *Trypanosoma vivax* and *Trypanosoma brucei* in the blood of horses, and although *T. vivax* seems to be the more common, *T. brucei* would appear to be the more virulent. But here our knowledge of the subject ends. It is practically certain that infection is not always carried from horse to horse, as has been shown in the case of Bassa, and therefore we have yet

to find the reservoir. Consequently a fruitful line of research lies open and would well repay investigation, namely, the discovery of the animal or animals which act as reservoirs of the trypanosomes which are responsible for the mortality amongst horses, and the insect or insects which convey the infection.

Piroplasmosis.

Piroplasmosis has been found in dogs in Zungeru, and it possibly also occurs in the Katagum district. No definite case of this disease in cattle has been recorded, but it must be remembered that practically nothing has been done to investigate the disease or diseases which kill off the cattle in Northern Nigeria, and although it is almost certain that trypanosomiasis is the chief factor, it is not improbable that some of the deaths are due to piroplasmosis.

IX. REMEDIAL MEASURES AND RECOMMENDATIONS.

At various points in the report, when discussing individual localities, I have indicated certain lines of action which might profitably be adopted, so that it is unnecessary again to enter into these in any detail. At the same time it might be advisable to recapitulate the more important items, as some are applicable to widely different localities.

Although recognising the immense advantages accruing from the extension of railway systems in opening up such a Protectorate as Northern Nigeria, one must not overlook potential dangers, and not the least of these is the possibility of extending the range of noxious insects and the introduction of insect-borne diseases to areas previously free. The same applies, though probably to a greater extent, in the case of river transport on launches and steamers.

Consequently every effort should be made to minimise such risks, in the case of railways, by clearing large spaces in close proximity to the permanent way in areas known to harbour such insects as are proved to carry, or suspected of carrying, pathogenic organisms. Until this is done the transport of cattle and horses in open railway vehicles is attended by grave risks, and it is certainly desirable that the trucks used for conveying these animals should be rendered mosquito-proof. By this means horses and cattle might be taken from one free area to another without infection, a procedure at present impossible. In the case of passenger traffic this would be impracticable, and the only solution of the problem is extensive clearing.

The case of river transport is very different, as certain factors, such as "bilge-water," which cannot be avoided, have to be taken into account. There is no doubt that mosquitos, and amongst them *Stegomyia fasciata*, do breed in such water. Only by careful supervision and the free use of oil can this be checked, and it is pleasing to record that this has commanded considerable attention from Dr. E. A. Chartres, the Senior Medical Officer at Lokoja. The co-operation of the Marine Department has also been enlisted in this work.

Certain other factors, however, present themselves, but these are more intimately connected with the construction of the vessels. In another report* I entered in some detail into the question of the mosquito-proofing of cabins,

* Bull. Ent. Res., II., pt. 3, pp. 210 and 226.

and this applies equally to the vessels which ply on the Niger. Further, in the individual cabins one usually finds the same wash-stand arrangement as is used on ocean-going steamers. Now this involves two separate receptacles for water, and on three different occasions I have found mosquito larvae in these vessels. It is difficult, if not almost impossible, when native servants are employed to ensure that these will be kept empty when not in use, and as stated above, they may thus be a source of danger. Consequently, to obviate this risk, vessels built for use on such rivers ought to have a central water supply conveyed by pipes from a mosquito-proof tank, and have also a system whereby the refuse water could be carried off *directly* in a similar manner. It is impossible to insist too strongly on the careful supervision of all water receptacles on launches and steamers.

With regard to individual localities, it is necessary to refer only to a limited number, as the suggestions here made may be applied to others with similar conditions. The following suggestions may be noted :—

Zungeru.—(1) The free use of kerosene in the pools left by the smaller streams during the dry season; (2) the proper sloping and systematic inspection of the gutters on the roofs of bungalows; (3) the removal of the residential quarters over the Government offices in Ike Square; (4) the necessity for an extensive clearing all round the cantonment; (5) the formation of a Government segregation camp for infected horses. This should be situated as far from the rivers as possible and in the centre of a large open clearing.

Lokoja.—Most of the remarks with regard to Zungeru apply equally well to Lokoja, but in addition to these the prevalence of *Stegomyia fasciata* along the river-bank area calls for special attention. The only feasible method of checking this pest seems to be the formation of a masonry or concrete wall along the river bank, more especially at those places where launches and steamers load and unload.

Baro.—Attention has already been directed to the necessity for filling up the large "ju-ju" swamp, and clearing on the lines already started should be most rigorously continued.

Kateri.—The town of Kateri and others in similar situations should be removed to the more open ground and a clearing of several hundred yards made around the watering places.

Bassa.—The rest camps at Lafia and Aiyangba might with advantage be removed farther from the kurimis. Villages, such as Egga, situated in a kurimi should be abandoned and others built in the open country. The European quarters at Ankpa ought to be immediately transferred to higher ground and separated from the thick bush by a large open clearing of several hundred yards. In this province as well as in others where the conditions are similar, for example, the Zungeru-Abuja Road and the Zaria-Abuja Road, clearings ought to be made at all places where the main routes cross rivers or pass through kurimis.

Sleeping Sickness Camps.—As already stated, a sleeping sickness camp has been inaugurated near Zaria, but from the point of view of the distribution of *Glossina palpalis*, and in the event of its being necessary to establish another, some region in the vicinity of Maiduguri or at any rate in the Chad river system ought to be selected.

Legislation.—Some sort of Mosquito Ordinance ought to be promulgated in Northern Nigeria, whereby, to aid the Sanitary Department in its work, it might be made a punishable offence to have tins and such-like receptacles lying about compounds. Further, it might be enacted that when due notice was given by the sanitary officer to have any water pits, etc., where mosquitos might breed, filled in, refusal or neglect to comply with the instructions might also be made a punishable offence.

An Ordinance ought also to be promulgated empowering the Senior Political Officer of the Province, on the advice of a Medical Officer, to have any person suffering from sleeping sickness removed to a segregation camp.

Subjects requiring further investigation.

Many profitable lines of research besides the geographical distribution of blood-sucking insects will present themselves to those interested in this subject, but I should like to draw attention to a few of these as suggested in the present report.

(1) A mosquito survey on the lines suggested in Dr. J. W. W. Stephens' paper in a former issue of this Bulletin.*

(2) The examination of the blood of all game, large and small, in the Protectorate for Protozoa.

(3) An investigation into the forms of trypanosomiasis in horses and cattle. Are there any distinct differences in the clinical symptoms in those animals infected with *Trypanosoma vivax* and those infected with *T. brucei*? Are there other species of Trypanosomes? Is there any difference in the distribution of the various forms of this disease? Which is the most virulent type? What is the relative susceptibility to treatment?

(4) Experiments to determine to what extent *Glossina*, *Stomoxys* or TABANIDAE are implicated in the transmission of trypanosomiasis.

(5) Observations to ascertain the breeding places of *Glossina* and other blood-sucking insects.

(6) An investigation into the occurrence of Piroplasmosis in various animals.

In conclusion, I wish to take this opportunity of recording my indebtedness to His Excellency the Governor, Sir Hesketh Bell, K.C.M.G., for the many facilities afforded by him and the personal interest he took in the investigation; to Mr. M. H. de la P. Beresford, Secretary to the Administration, for the expeditious way in which all arrangements were carried out; to Dr. S. W. Thompstone, C.M.G., the Principal Medical Officer, for his kind co-operation and many suggestions based on a long experience of the Protectorate: to Dr. Cameron Blair, the Senior Sanitary Officer and Dr. J. W. S. Macfie, with whom I spent a considerable time on trek; to all those who have sent collections and whose records are included in this report and also to the various officials, medical and political, in whose Provinces I travelled, for their kind hospitality, the whole-hearted support which was everywhere evidenced, and the many ways in which they aided in carrying through the investigation expeditiously.

* Bull. Ent. Res. II, pt. 1, pp. 1–8.

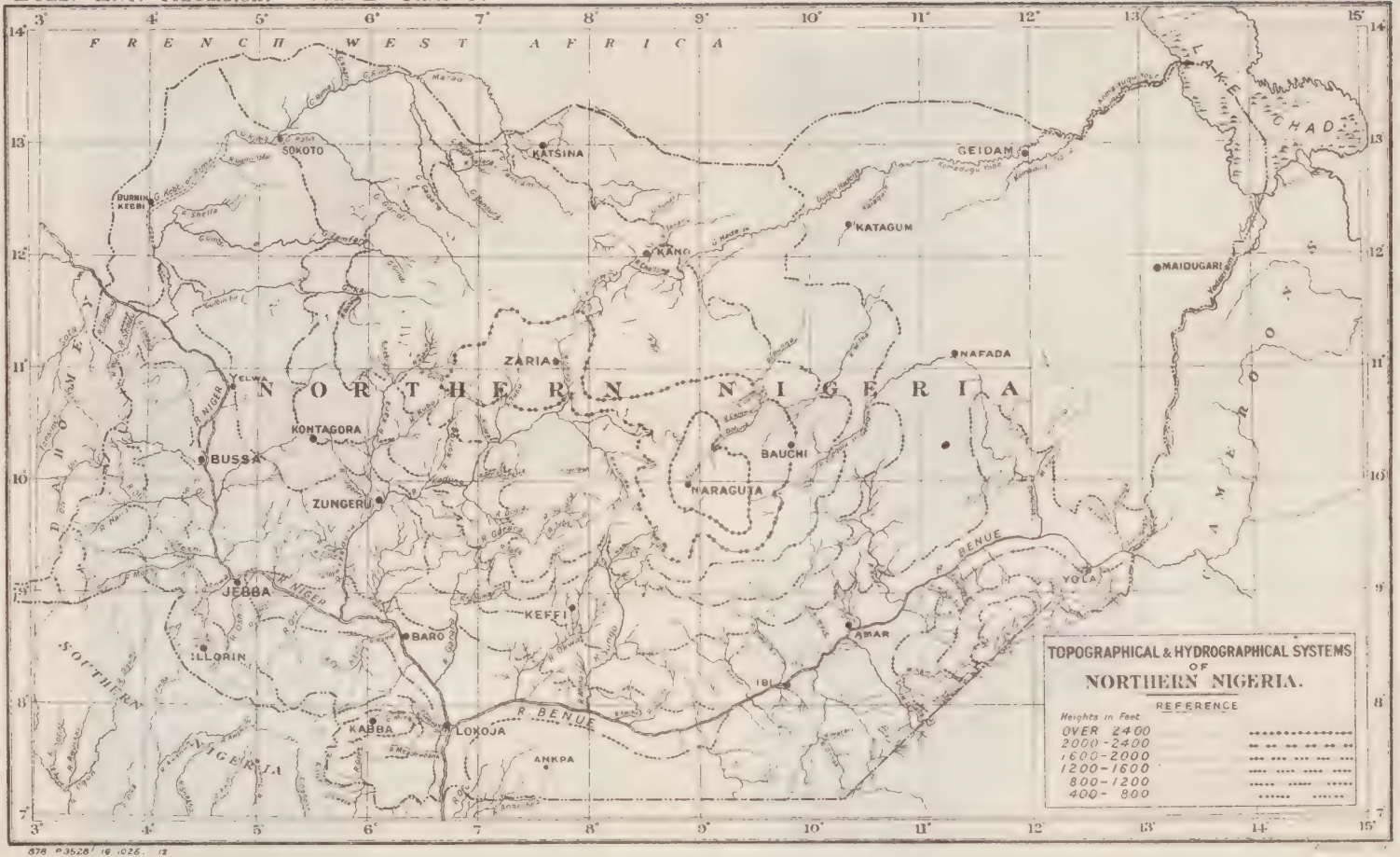

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Fig. 1. View on the Niger near Bajibo, to show the nature of the vegetation on the banks.

Fig. 2. On the Niger at Jebba, showing the "ju-ju" rock.

Fig. 1. The bank of the Niger near Mureji.

Fig. 2. The town of Mureji at the junction of the Kaduna and the Niger.

Fig. 1.

Fig. 2.

Views to show the nature of the vegetation on the banks of the rivers in the Kontagora Province.

General view of the town of Baro.

Fig. 1. View at Minna, to show the nature of the country through which the Baro-Kano Railway runs in this region.

Fig. 2. Typical rest-house in the Northern Districts.

Fig. 1. View on the River Benue, during the dry season, showing the extensive sand-banks which are submerged in the rainy season.

Fig. 2. View on the River Kaduna (during the dry season) at the point where it is crossed by the Baro-Kano Railway.

Fig. 1.

Fig. 2.
Typical vegetation of a kurimi.

Fig. 1. Village situated at the edge of a kurimi in the Kateri District.

Fig. 2. Typical entrance to a village situated in a kurimi in the Kateri District.

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NORTHERN NIGERIA

MAP to accompany REPORT
by
JAS. J. SIMPSON,
Showing the distribution of GLOSSINA
and SLEEPING SICKNESS.

Localities where *Glossina palpalis was found* ●
" " *G. tachinoides* ■
" " *G. submorsitans* ⊕
" " *G. longipalpis* ■
" " *Sleeping sickness* ●
Route followed by the Author ----

REFERENCE

Boundaries international
intercolonial
provincial
Railway
proposed
Roads with
without
Rest House
Ruins
Telegraphs along roads
Tramway
Provincial and District names shown in red
Tribal names shown in green

Scale 2000000 or 1 014 Inches to 32 Miles
Miles 30 20 10 0 50 100 150 200 Miles
Kilometres 50 40 30 20 10 0 50 100 150 200 250 Kilometres
1 Centimetre to 20 Kilometres

Anchorage
Customs Station
Naval Dockyard or Arsenal
Telegraph Office
Toll Station

Available information as to

Compiled in the War Office from boundary commission surveys and route traverses adjusted on certain towns fixed by latitudes and telegraphic longitudes. Partly engraved by Messrs Philip & Son, completed and printed in the War Office

War Office, 1909.

Geographical Section, General Staff, No 2461.

OBSERVATIONS ON THE BREEDING HAUNTS OF GLOSSINA MORSITANS.

By Rupert W. Jack, F.E.S.,

Government Entomologist for Southern Rhodesia.

(PLATES XVII.—XXI.)

The first puparium of *Glossina morsitans* found in nature, as mentioned in Mr. E. E. Austen's recently published "Handbook of the Tsetse-Flies," was taken in November, 1910, from the collection of mould and humus between the roots of a large tree (*Ficus sp.*) near the Gorai river below the Escarpment in the Lomagundi District, Southern Rhodesia. The tree is situated about 60 to 70 yards from the actual bank of the river, as it runs at present. It is in reality growing on what was the old bank of the river, which is changing its bed gradually owing to the soft nature of the ground through which it flows. At the time of the visit "fly" was abundant in the shade of the trees bordering the river, the sandy bed of which then contained no water on the surface, the nearest open water being twelve to fifteen miles away in the Hunyani river. It was thought at the time that this was the only pupa-case secured, and a search all along the river bank produced no others. A number of empty pupa-cases of other Diptera and Lepidoptera were, however, placed in a corked phial and labelled, and on going over these later in the laboratory, the anal end of a second tsetse pupa-case was found amongst them, showing the characteristic protuberances. This spot was again visited in April, 1911, and under the same tree five more empty puparia were found, but, as before, the most diligent search elsewhere failed to produce any more. A photograph of the tree taken in November is reproduced (Pl. XVII, fig. 2).

During August, 1911, the fly-area in the Sebungwe District was visited, and here the search for pupae met with greater success. Altogether 87 empty puparia were found and four living pupae, or at least puparia from which the fly had not emerged. These puparia were found in two different localities, namely, at a river, or, as some say, the headquarters of several rivers, called Manzituba, lying some 35 miles east of Kariyangwe (Sebungwe), the seat of the Native Commissioner for the district; and again, near a kraal belonging to the induna Sinombi, situated on the Sinyama River, about 23 miles east of Kariyangwe.

At the point where the investigations took place at Manzituba there is a sandy escarpment, a hundred feet or so in height, which suddenly descends to a wet boggy vlei,* lying east and west, through which the course of the river runs. In August the river consists of a series of pools. This vlei is bordered by shady trees, and in this respect differs from the surrounding bush, in which the trees are almost entirely leafless at this time of the year. From the drier portions of the vlei old termite-mounds rise in places and are surmounted by tall shady trees.

* [A term used in South Africa for open, low-lying land, which is always marshy during the rains, but which may or may not be dry during the dry season.—Ed.]

About the shady borders of this vlei tsetses occur in the greatest numbers in August, and at the bases of the trees, where conditions were favourable, the puparia were found. In every case the puparia were in the soil, either sheltered by a hollow in the trunk of a tree, or, when there was a very sharp incline, as on an "ant-heap," under the exposed roots. Generally the soil was sandy and soft, and often much humus, dead leaves and vegetable debris were present. One or two puparia were, however, found in hard soil even as deep as one and a-half inches. As it is not to be thought that the larvae could have penetrated baked "ant-heap" to this depth, one can only conjecture that the cases were very old, and that the larvae entered by a crack or division between the soil and the trunk of the tree, not apparent at the time of digging. The following is a list of the situations where puparia were found at Manzituba :—

(1) Two large Mubula trees (*Parinarium mobola ?*) within a few yards of the edge of a pool of the river; six empty puparia were found in August; gentle slope towards river; soil sandy clay, moderately soft, leaves and humus present; the puparia were taken in earth in hollows at the base of the trunks (Pl. XVIII, figs. 1, 2).

(2) Clump of Mubula trees on "ant-heap" on edge of vlei, about 100 yards from the river; sharp slope on all sides; soil sandy, much dead leaves and vegetable debris; 25 empty pupa-cases were taken from hollows about the roots of the trees on the top of the heap and on the sloping sides. Here two pupae were found in hard earth one and a-half inches from the surface; the top of the earth was covered with leaves and vegetable debris (Pl. XVII, fig. 1).

(3) Mopani tree (*Copaifera mopani*) on "ant-heap" on edge of vlei, 150 yards from the river, on a sharp slope. There was a collection of humus in the hollow where one empty puparium was found (Pl. XIX, fig. 1).

(4) Clump of Mudlaoza trees (botanical name unknown) on "ant-heap" in vlei, 50 yards from the river. One pupa-case in a hollow of the root on the sloping side; soil very hard on the heap, but a collection of humus at the spot where the case was found (Pl. XIX, fig. 2).

(5) Clump of small unknown trees on the bank of a pool in the river. Three empty puparia were found in the earth on the upper side (away from the water); situation close to the trunk, and sheltered (Pl. XX, fig. 1).

(6) Clump of Mubula trees on "ant-heap" in vlei, about 100 yards from the river. Four empty puparia were taken on the sloping side, amongst the roots; soil sandy, humus and vegetable debris present.

Negative results were obtained from the soil under bushes, although shaded, sloping, loose, full of humus and covered with leaves. A very considerable amount of time was devoted to digging in such situations. The writer is of the opinion that the instinct of the parent fly is to avoid such places where the pupae would be in danger from the scratching of game birds, etc. Digging at the bases of the mopani trees and the common species of *Brachystegia* in the unshaded forest away from the river also produced negative results. The soil is almost invariably very hard there, and *G. morsitans* does not haunt these parts in the dry weather after the trees have lost their leaves.

At Sinombi, the Sinyama River is met by a tributary stream, and the valleys run north, south and west. Along these valleys and on the actual banks of the streams a number of fine shady trees are found which are in full leaf in August, and here the tsetses congregate. On the hills around, the forest is leafless and affords but little shade. Puparia, for the most part empty, were found at the bases of the shady trees, mostly on sharply sloping ground, but not invariably. The list of the situations where the puparia were found is as follows :—

(7) One empty puparium found at the base of an unidentified tree, on the sharply sloping bank of the river: position shaded by bushes: soil sandy and loose, with much humus, etc.

(8) Baobab tree (*Adansonia digitata*) on sharply sloping bank of river. Thirty-nine empty cases and three live pupae were obtained, mostly under exposed roots on the sloping side. Soil loose and sandy, with abundant humus, etc. (Pl. XX, fig. 2). Two empty cases and one live pupa were taken from a small hollow in

Fig. 1.—Another view of the Baobab tree shown in Plate XX, fig. 2.

the trunk on the upper side of the tree, about 2 feet 6 inches from the surface of the ground. The hollow was cup-shaped inside and full of humus. Numerous empty pupa-cases of other Diptera and Lepidoptera were present and also living specimens of each (text-fig. 1).

(9) Baobab on hill above the river. Four empty cases from hollows and under roots on the sloping side: soil loose and sandy, leaf mould abundant. This

tree was away from the influence of the river, so far as providing shade in August was concerned, and there were no *Glossina* congregating near it. Probably the larvae were deposited when the surrounding trees were in leaf (Pl. XXI, fig. 2).

(10) Ababa tree (botanical name unknown) on level ground near the river. The grass had been burnt off on the previous day; soil sandy, but dead leaves and leaf mould absent. One live pupa was found sheltered under a hollow made by previous grass-fires in the trunk. The soil sloped down towards the trunk, but the pupa was in a ridge of soil against the trunk itself (Pl. XXI, fig. 1).

(11) Mvumila tree (probably *Kirkia acuminata*) on a bank sloping sharply to the river. Three puparia found in a protected position close to the trunk on the upper side; soil loose and sandy, vegetable debris abundant.

Searching in the leaf mould, etc., beneath bushes on the banks of the river, near the trees where the pupae were found, again proved fruitless at Sinombi, and this, coupled with the results at Manzituba, and the very prolonged searches made in such situations near the Gorai River, Lomagundi, in November and April, leads me to the opinion that such spots are rarely if ever selected for the deposition of the larvae. The tsetse-fly is such a comparatively slow breeder that it can scarcely afford to expose its pupae to the scratchings of the game birds which frequent exactly the same haunts as the fly during the dry weather, and often in amazing numbers. Along the Gorai River in November the numbers of guinea fowl, "pheasant" (*Pternistes*) and "redwing" (*Francolinus*) were astonishing. They rose at almost every step along the banks, and all the ground under the bushes had been scratched over and over again. In April they were, however, not more than ordinarily abundant.

It has already been stated that *G. morsitans* congregates on the shady banks of rivers and borders of vleis in the dry weather. In the wet season, when the forest is shady, the fly is much more generally distributed through the veld. This statement is based on the following observations:—(*a.*) In the Hartley district there are one or two farms on the railway line, and within three or four miles of a fly-belt on the Surisuri River. It was found that for three consecutive years some cattle on these farms became fly-struck in February and March, but no cases occurred during the dry weather. The wet season opens in December there. The writer took almost monthly observations on the fly-belt in 1909–10, and the fly was taken only near two tributaries of the Surisuri during the dry weather. In February, 1910, however, fly was found in the bush at several points away from these tributaries, and one specimen on the borders of one of the farms where cattle had been struck, within a mile and a half of the homestead, and this (an important factor) on the *outward* journey. (*b.*) Below the Escarpment in Lomagundi, in November, 1910, *G. morsitans*, was found congregated on the Gorai River, and on the Dandi and Ambi Rivers near their junction, and also in the shady borders of a vlei not far from the Dandi. In April the fly was not congregated at any of these places. Near the Gorai River, it occurred perhaps mostly in the mopani belts, a mile or two from the river, but was to be found all over the veld, and the same state of things was observed near the Ambi and Dandi Rivers, and in the vlei mentioned above. (*c.*) Near

Tchetchenini Hill the fly occurred in ones and twos all through the bush in April, 1911. (*d.*) Near the Umniati and Sakugwe Rivers, after the opening of the rains, in December, 1910, tsetse was everywhere distributed generally through the veld, and could not be said to be congregated anywhere. (*e.*) On the Lubu, Sinyama and Manzituba Rivers in the Sebungwe district, in August, 1911, the fly was congregated in the shady borders of rivers and vleis.

It is probable then that, whilst the deposition of larvae takes place during the dry weather chiefly along the banks of rivers and in similar shady spots, during and immediately after the rains they may be deposited generally through the forest. The finding of puparia about the baobab on the hill (*supra*, no. 9) supports this view, as this tree was away from the river and winter shade.

Fig. 1. Clump of Mubula trees on an "ant-heap," near the Manzituba River.

Fig. 2. Fig tree near Gorai River, below Escarpment, Lomagundi, east of Hunyani River.

Fig. 1. Bases of Mubula trees on the bank of the Manzituba River, Sebungwe District

Fig. 2. Base of further tree in the above photograph, showing the hollow in which the puparia were found.

Fig. 1. Base of Mopani tree on an "ant-heap" near the Manzituba River

Fig. 2. Clump of Mudlaoza trees on an "ant-heap" near the Manzituba River.

Fig. 1. Clump of trees on the bank of a pool of the Mandubu River.

Fig. 2. Base of Baobab tree on the bank of the Sinyama River, near Sinombi's Kraal, Sebungwe.

Fig. 1. Base of Ababa tree close to the Sinyama River, Sebungwe.

Fig. 2. Base of Baobab tree on hill near Sinyama River, Sebungwe.

ON A NEW GENUS AND SPECIES OF CLINOCORIDAE (CIMICIDAE) FROM ~~UGANDA.~~

By the Hon. N. Charles Rothschild, M.A., F.L.S.

Loxaspis, gen. nov.

Reflexed margin of pronotum very narrow. Scutellum transversely oblong, produced into a small point in the centre of the hind margin. Elytra transverse, widest towards the suture. Tibia with a pseudo-joint at about four-fifths.

Genotype: *L. mirandus*, sp. nov.

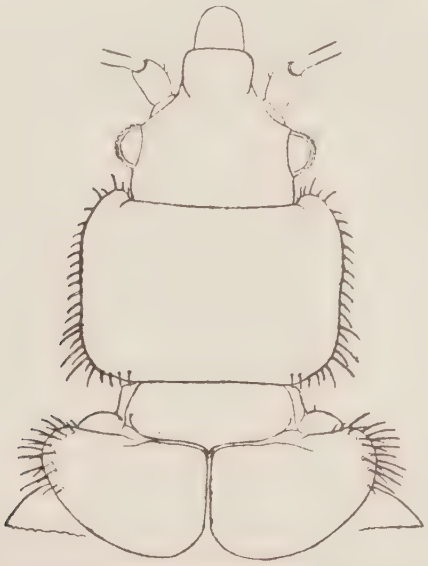


Fig. 1.—Head and thorax of *Loxaspis mirandus*, Roths.

Loxaspis mirandus, sp. nov.

Head, thorax, elytra, abdomen and legs densely covered with very fine hairs inserted in pits; colour dark brown.

Head (without labrum) one-fifth shorter than the pronotum, and standing well out from it. Relative lengths of joints of antennae as follows:—6 : 28 : 24 : 24, the third and fourth joints being of about the same thickness. The rostrum when at rest extends to the middle of the anterior coxae.

Pronotum at the apex not sinuate, almost truncate, and of equal width throughout, the sides being slightly incurved; anterior angles slightly produced but not reaching half-way towards the eye; posterior edge also truncate; explanate margin narrow, slightly reflexed and of the same width all round except at the apical angle, where it is very slightly widened; the marginal hairs of the pronotum differ in length, those at the anterior portion being slightly shorter than

the width of the eye, while some of those at the posterior portion are about as long as the width of the eye. Scutellum transverse and of almost the same width throughout, but the posterior edge is produced into a minute point in the centre fitting into the elytra; the lateral edges of the scutellum do not cover the dorsal surfaces of the pleura. The elytra transverse, widest towards the suture, and shortest at the sides, sutural angle completely rounded off, basal margin almost straight except for being incurved at the centre, apical margin rounded. The elytra bear at and near the lateral margin about ten hairs slightly longer than the width of the eye.

Prosternum glabrous in the centre of the chitinized portion. Mesosternum with a patch of hairs in the centre, besides 5 or 6 longer bristles at the lateral edges. Metasternum very characteristic, lanceolate, being widest in the centre and narrowing backwards and forwards.

The bristles of the posterior row of the abdominal tergites 1 to 5 are prolonged, being more than twice the length of the anterior hairs of these tergites. The bristles at the sides of the posterior tergites are short and hardly project beyond the edge of the abdomen.

The femora are rather stout, with an irregular row of short hairs on the upper surface. All the tibiae possess a pseudo-joint at about four-fifths of their length, a very distinctive character not known in any other species.* Apical tuft of hair very distinct in the fore and mid-tibiae, but absent in the hind tibiae. All the bristles of the tibiae are pointed and not truncate. The relative lengths of the femora, tibiae, and tarsi of the hind leg are as follows :—46 : 55 : 17.

The eighth sternite of the male is asymmetrical, with a bunch of spine-like truncate hairs situated on each side. The female has numerous spine-like truncate hairs ventrally at the apex of the abdomen.

Length, 4 mm.

Five examples of this remarkable insect were collected by Mr. F. J. Jackson, C.B., C.M.G., Governor of the Uganda Protectorate, on the 12th February, 1911, at Kilindini, near Mombasa, and were found in a house in which alterations were being carried on, and which contained under the roof large numbers of the "White-winged Bat," most probably *Taphozous hildegardeae*.

* This character is absent in all the known species of CLINOCORIDAE and is only found among insects in the POLYCTENIDAE and in some of the NYCTERIBIIDAE, both of which are parasites of bats. In the two species of *Clinocoris* previously recorded from bats (*pipistrelli*, Jenyns, and *pilosellus*, Horvath), pseudo-joints are absent.

AN ATTEMPT TO CONTROL INSECT PESTS BY THE INTRODUCTION OF PARASITES.

The Importation into the United States of the Parasites of the Gipsy Moth and the Brown-tail Moth—a Report of Progress. By L. O. Howard and W. F. Fiske. Bureau of Entomology, U. S. Department of Agriculture, Bulletin no. 91, pp. 1–312, July 29, 1911.

In the introduction to this voluminous report the senior author states that no work of this magnitude has been hitherto attempted and discusses similar work elsewhere. Success in parasite introduction, apart from work against fixed scale insects, has been limited to the parasites of the sugar-cane leaf-hopper in Hawaii, "some reported work" in introducing South American fruit-fly parasites to Australia, and the transfer to California of one parasite of codlin moth from Spain. "It seemed to the writer that by attempting to reproduce in New England as nearly as possible the entire natural environment of the gipsy moth and the brown-tail moth in their native homes, similar conditions of comparative scarcity could surely be reached, and this view he still holds with enthusiasm." (L. O. Howard). That is to say, an endeavour was to be made to reduce these two moths, which now occur in the United States in enormous numbers, to the condition of comparative rarity which they exhibit in Europe, by reproducing as nearly as possible their natural environment, so far as their insect enemies are concerned.

The initial idea was to send to America large quantities of caterpillars, and to rear from them parasites, which would then be let loose in localities where the pests abounded and would breed there. It was hoped by this means to establish in America the parasites that check these species elsewhere. This method, which seems a simple one, was decided upon partly because the moths themselves were introduced and established so casually, and it was thought it would be quite easy to introduce their checks. Gipsy moth was brought to Massachusetts in 1868 or 1869 and escaped by accident. For 10 years it attracted little notice, then it increased, and in 1889 it became a serious pest. From that date until 1900, up to a million dollars a year was spent in fighting it; then the operations were suspended for five years, and in consequence the pest spread from an area of 359 square miles over 2,224 square miles. In 1905 the present effort was commenced by the Federal Department.

Brown-tail moth was introduced in the early '90's and has spread rapidly as the females fly readily.

The author goes into considerable and unnecessary detail over his travelling in Europe and the arrangements made to start the work. One of the things learnt after a few years was that it was not a simple matter to establish parasites; a small colony simply put out in a locality disappeared in many cases, due apparently to dispersal so rapidly that they did not find mates. It was found that it was

necessary first to establish, then to disperse, and therefore no small colonies were put out. In some cases introduced parasites were found again after having been lost sight of for three or four years, and some species now lost may in this way reappear.

The known parasites are enumerated below in three columns : the number of species recorded by previous authors is shown in the first ; the previously recorded species which were actually bred from sendings from abroad are in the second ; while new ones bred from these consignments are in the third.

	Previously recorded.	Recorded species bred.	New parasites bred.
Gipsy Moth :—			
Braconidae	10	2	3
Ichneumonidae :			
Primary	11	3	7
? Secondary	9	—	—
Chalcididae	6	1	4
Tachinidae	20	4	6
	56	10	20
Brown-tail Moth :—			
Braconidae	13	1	1
Ichneumonidae :			
Primary	9	3	1
? Secondary	3	—	—
Chalcididae	9	1	4
Proctotrypidae	1	1	—
Tachinidae	7	3	13
	42	9	19

There were 56 previously recorded parasites of the gipsy moth, of which 10 were reared, and 20 more found, giving a total of 76 species ; while of the brown-tail moth, 42 had been recorded, of which the authors bred 9, together with 19 new ones, making a total of 61 different parasites.

As the two moths were themselves liberated by accident, it was thought that it would be easy to establish a parasite if enough specimens were obtained ; the species reared were therefore let loose in small colonies. Useful results were also anticipated from a predaceous beetle, *Calosoma* ; this was found to remain for several years where placed before dispersing. In the case of an egg parasite, *Anastatus*, the dispersal rate was shown to be only a few hundred feet per year. In *Monodontomerus*, the male and female couple in the host, so that fertilisation at least takes place, favouring distribution. Many hymenopterous parasites (and very likely all) are capable of parthenogenetic reproduction ; some are thelytokous (producing females only), and so easy to rear ; others are arrhenotokous (producing males only), but couple with their offspring and give a good fertile race. *Monodontomerus* spread 200 miles in 5 years, but is exceptional. Tachinids are rarely, if ever, parthenogenetic.

In 1907 it was found that small colonies failed and subsequently larger colonies only were put out. "It may be, after all, that 40,000 individuals of *Apanteles fulvipes* are not enough to make one good colony."

Disease has been a factor, *i.e.*, a fungus disease in the brown-tail and a disease like "flacherie" (silkworm disease) in the gipsy moth; but these are apparently ineffective as checks. Studies were made of the parasites of various indigenous Lepidoptera. Parasitism plays a different part in every species, and while some are extensively parasitised and checked, others have only a limited number of parasites none of which becomes abundant. The authors conclude that no single parasite will be effective, but that a sequence of different parasites will be necessary, attacking the egg, larva and pupa consecutively. The problem they have to solve is the establishment of such a complete sequence. The authors further distinguish "catastrophic" from "facultative" control. In the former class of checks, which are mostly climatic, such as storms, frosts, etc., the average percentage of destruction remains the same, no matter how common or rare the pest may be; but a "facultative" check is one which becomes relatively more effective as the pest becomes more abundant, thus operating to prevent undue increase. It is further assumed that "each species of insect in a country where the conditions are settled is subjected to a certain fixed average percentage of parasitism, which, in the vast majority of instances and in connection with numerous other controlling agencies, results in the maintenance of a perfect balance." In order that this balance may exist there must be at least one "facultative" check.

Birds, and similar predaceous foes, are considered to exert no "facultative" control whatever; this is directly opposed to the present writer's view.

The authors in fact give controlling agencies as :—

(1) Catastrophic (storms, etc.)—killing a percentage only, irrespective of abundance.

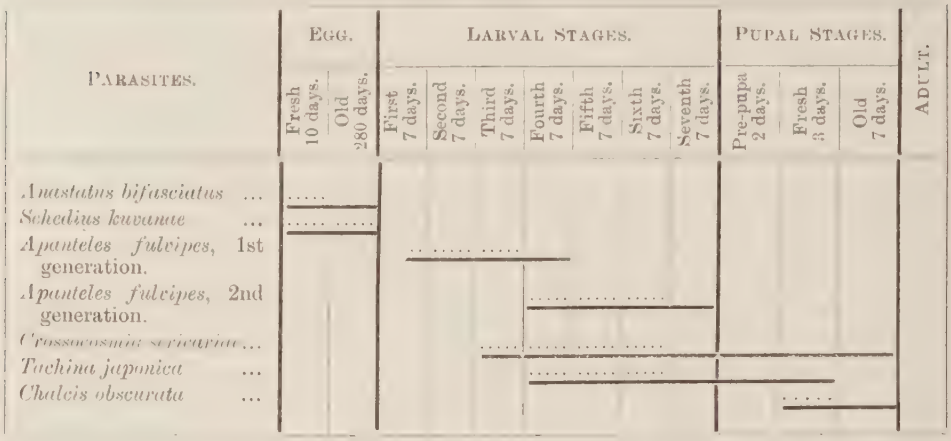
(2) Predatory (birds, etc.)—killing a gross number only in any year, irrespective of abundance.

(3) Facultative—increasing automatically as the insect preyed upon becomes more abundant.

Calculations were made as to the amount of parasitism necessary to keep the gipsy moth in check. It was estimated that, taking egg-masses for instance, for every one that existed in the spring, six were laid in the autumn; that is to say, that in the United States, the rate of increase then was actually six-fold. If therefore it was desired to keep the species down to an innocuous level it would be necessary to kill five-sixths of the total insects yearly, or 83 per cent. In any case the death rate would have to be maintained at not less than 75 per cent.

The investigators were anxious to determine whether the gipsy moth was controlled by parasites in other countries; and if so, whether the parasitism was anywhere so effective as to kill 75 per cent. of the insects. On this point no information was available, and attempts were made to discover it from the material collected elsewhere and sent to them. This was unsatisfactory, so far as figures went, but the authors give tables showing the

sequence of parasites in certain localities. Japan is one locality in which the moth is supposed to be controlled, and they give a table as follows :—



In this table the vertical columns indicate the various stages in the development of the moths, with their duration. The dotted line following the name of the parasite shows the stages during which the moth is likely to be attacked by that parasite, while the solid line indicates the stages during which it is likely to contain this parasite in its body. Six other species, indicated by the authors as probably unimportant, have been omitted from the table, which shows a complete sequence of attack.

In Russia, it was found that in some areas parasites were plentiful, while in others parasites were few, but that an epidemic of disease had very much reduced the pest.

In France, the parasitism of the gipsy moth was found to be much less than was anticipated, ranging only from 25 to 40 per cent., but the conditions of the insects' life were so adverse otherwise that this was not considered surprising. It is urged that this difference in the conditions, with the resulting alteration in the habits of the moth, as compared with what obtains in the United States, does not permit of the deduction that parasitism would be ineffective in the latter country.

One is impressed with the desire of the authors to reconcile facts with hopes, rather than to base their hopes on the facts. They endeavour to account for the poverty of parasitism and come from their explanations with renewed hope.

Brown-tail moth parasites were studied from Europe only, where it is less checked by parasites than gipsy moth. A disease attacks this species, which may be of importance, and which already occurs in the United States. A sequence is given for its parasites.

Gipsy moth parasites in America are discussed in detail. *Tachina mella*, Wlk., is interesting, being a fly which lays eggs on the caterpillars. The fly larvae frequently fail to live and the moth emerges : this may be due to one of the following causes :—(1) absorption of the larvae, on penetrating the skin, by phagocytes ; (2) the larva penetrates and lives in a funnel formed under the

skin, which may be moulted intact; (3) moulting of the eggs with the skin; (4) failure of the larva to penetrate.

A full account is given of the methods adopted for importing and handling the enormous numbers of eggs and caterpillars of the two moths which were needed in order to rear a good stock of parasites. Each species of parasite is then discussed in detail, and this section contains a mass of interesting and useful information respecting the individual species studied.

The following tabulated statement will give some idea as to the measure of success which has attended these attempts at colonisation.

Parasites of the Gipsy Moth.

Egg Parasites (Hymenoptera).

Anastatus bifasciatus, Fonsc.	Apparently well established.
Schedius kuvanae, How.	Establishment very doubtful on account of climatic conditions.

Larval Parasites (Hymenoptera).

Apanteles fulvipes, Hal.	Establishment doubtful on account of lack of proper alternate hosts.

Larval Parasites (Tachinidae).

Compsilura concinnata, Meig.	Apparently established.
Blepharipa scutellata, R. D.	Establishment confidently expected.
Carcelia gnava, Meig. *Zygobothria gilva*, Hartig. *Tricholyga grandis*, Zett. *Parasetigena segregata*, Rond.	Establishment hoped for.
Tachina larvarum, L. „ *japonica*, Towns. *Crossocosmia spp.*	Establishment doubtful.

Pupal Parasites (Hymenoptera).

Monodontomerus aereus, Walk.	Firmly established and dispersing at a very rapid rate.
Pimpla examinator, F. „ *instigator*, F. *Chalcis obscurata*, Walk. „ *flavipes*, Panz.	Establishment doubtful.

Predaceous Beetles.

Calosoma sycophanta, L.	Firmly established; increasing and dispersing rapidly.

Parasites of the Brown-tail Moth.

Egg Parasites (Hymenoptera).

Trichogramma spp. *Telenomus phalaenarum*, Nees.	Establishment probable; not important.

Larval Parasites (Hymenoptera).

Pteromalus egregius, Först.
Apanteles lacteicolor, Vier.
Meteorus versicolor, Wesm. } Apparently well established.

Larval Parasites (Tachinidae).

Zygobothria nidicola, Towns. Apparently firmly established.
Compsilura concinnata, Meig.
Tachina larvarum, F. } See under gipsy moth.
Dexodes nigripes, Fall. Establishment hoped for.
Eudoromyia magnicornis, Zett.
Pales pavida, Meig.
Parexorista cheloniae, Rond. } Establishment doubtful.

Pupal Parasites (Hymenoptera).

Pimpla examinator, F.
„ *instigator*, F.
Monodontomerus aereus, Walk. } See under gipsy moth.

Totals colonised—

Hymenoptera	1,794,640
Tachinidae	68,343
Calosoma	18,835
	1,881,818

The authors thought in 1909 that they could foresee the end of their work in 1916. They consider that they failed in their importations to some extent in 1910, and that their establishments were not so promising; but they hope to make up for this in 1912, and still look to ultimate success in 1916.

In commenting upon such an undertaking, one must remember how easy it is to be wise after the event, and the very fact that the work done has been set forth with the most elaborate detail, facilitates criticism. Indeed, the general impression given is that the work has been over-elaborated, and if only the unquestioned energy of all those concerned in the investigation had been restricted severely to a few of the more important lines of enquiry, it seems possible that more definite results might have been obtained. For whatever the hopes for the future may be, it cannot be denied that success has not yet been achieved.

In fact, the undertaking might almost be regarded as a failure from the larger point of view. Perkins, in Hawaii, has obtained better results with far less effort, and at much less cost: so have others, whose efforts are scarcely, if at all, referred to in this bulletin, though it professes to give a summary of all such experiments. Many entomologists see in this line of work the best promise for the future, and it is to be trusted that this publication will not damp their enthusiasm.

On a point of detail, it is difficult to agree with the authors in their inclusion of birds in catastrophic checks. There is good reason to think that birds are a "facultative" check, in that they eat abundant insects, and so tend to check only those species that become abundant; their effect increases with the increase of the insect, and they are, in the best sense, facultative.* How far this applies in the case of the two species of moths under consideration and the American birds the writer does not know, but on general grounds he differs from the authors on this point.

But despite all criticism, the fact remains that this huge experiment is a work of the highest importance, and in many of the details other workers will find much information of the greatest value.

H. Maxwell Lefroy.

* [One of the most striking cases of birds operating as a "facultative" control is to be found in the so-called "lesser locust-birds," the wattled starling (*Dilophus carunculatus*), of South Africa. Mr. C. P. Lounsbury appears to be of opinion that these birds constitute the most effective natural check upon the plague locusts of that country.—Ed.]

COLLECTIONS RECEIVED.

The thanks of the Entomological Research Committee are due to the following gentlemen, who have kindly presented collections of insects (received between 1st July and 30th September, 1911) :—

Dr. W. M. Aders :—1 *Chrysops*, 10 *Haematopota*, 23 *Tabanus*, 5 *Stomoxys*, 4 Hippoboscidae, 26 Coleoptera, 2 Lepidopterous larvae, 42 Coccidae, and 11 other Rhynchota, 43 Termites, 2 Orthoptera, and 36 Fleas ; from Zanzibar.

Mr. T. J. Anderson :—174 Culicidae, 4 Hippoboscidae, 671 other Diptera, 136 Coleoptera, 677 Lepidoptera, 230 Hymenoptera, 16 Planipennia, 42 Odonata, 5 Orthoptera, 4 Rhynchota, and 20 Ticks ; from British East Africa.

Dr. H. A. Bödeker :—27 Culicidae, 6 *Haematopota*, 2 Hippoboscidae, 32 Coleoptera, 55 Lepidoptera, 5 Hymenoptera, 1 Dragonfly, 3 Orthoptera, and 3 Rhynchota ; from British East Africa.

Mr. A. M. Champion :—11 *Diatomineura*, 3 *Auchmeromyia*, 13 other Diptera, 1 Beetle, and 1 Dragonfly ; from Kitui, British East Africa.

Dr. E. A. Chartres :—11 Culicidae, 1 *Haematopota sp. nov.*, 3 *Glossina*, 5 other Diptera, 3 Lepidoptera, and 1 Dragonfly ; from Lokoja, Northern Nigeria.

Dr. B. W. Cherrett :—3 Anopheline Mosquitos : from Nandi, British East Africa.

Dr. J. Currie :—98 Coleoptera, 2 Orthoptera, and 44 Rhynchota ; from Ibadan, Southern Nigeria.

Dr. Lyndhurst Duke :—1 *Culicoides milnei*, 1 *Haematopota sp. nov.*, 1 *Tabanus irroratus*, 1 *Stomoxys sp. nov.*, 1 *Henicocephalus sp.*

Mr. T. E. Fell :—22 Culicidae, 5 Tabanidae, 59 *Glossina*, and 2 other Diptera ; from Ashanti.

Mr. C. C. Gowdey :—3 Culicidae, 5 *Tabanus*, 96 *Haematopota*, 129 other Diptera, a number of Chalcididae, 115 other Hymenoptera, 326 Lepidoptera, 594 Coleoptera, numerous Coccidae, 344 other Rhynchota, 86 Orthoptera, 7 Neuroptera, and 135 Ticks ; from Uganda.

Mr. J. A. Ley Greaves :—142 *Glossina palpalis*, 1 *G. fusca*, and 1 *G. longipalpis* ; from Northern Nigeria.

Dr. F. L. Henderson :—15 Bugs and 18 Ticks ; from Mombasa, British East Africa.

Mr. E. Hutchins :—2 *Tabanus* and 38 Anoplura (*Haematopinus sp.*) ; from Uganda.

Dr. W. D. Innes :—15 *Glossina tachinoides* ; from the Alo River Northern Nigeria.

Dr. Robt. E. McConnell :—9 Culicidae, 6 Culicid larvae, 8 *Haematopota*, 10 *Tabanus*, 4 *Glossina*, and 4 other Diptera ; from the Nile Province, Uganda..

Dr. P. H. Macdonald :—23 *Culicoides grahami*, 5 Ceratopogonine larvae, 43 Culicidae, 2 Culicid larvae, 6 *Chrysops*, 22 *Glossina*, 31 larvae of *Auchmeromyia luteola*, 5 Fleas, and 2 Ticks ; from Bende, Southern Nigeria.

Dr. J. W. Scott Macfie :—A number of Culicidae, 195 Tabanidae, 36 *Glossina*, 85 *Lyperosia*, 48 Hippoboscidae, 319 other Diptera, 2 Dipterous pupae, 305 Coleoptera, 5 Coleopterous larvae, 1879 Lepidoptera, 1 Trichopteron, 328 Hymenoptera, 33 Planipennia, 42 Cimicidae, 213 other Rhynchota, 104 Orthoptera, 80 Odonata, 146 Anoplura, 2 Siphonaptera, 50 Ticks, 18 other Arachnida, and a number of intestinal worms ; from Northern Nigeria.

Dr. C. H. Marshall :—20 Culicidae and 7 other Diptera ; from Uganda.

Dr. A. Mouat :—9 Culicidae ; from Kisumu Township, British East Africa.

Dr. J. C. Murphy :—404 Culicidae, 59 Tabanidae, 50 *Glossina palpalis*, and 3 *G. fusca* ; from Daru, Sierra Leone.

Mr. T. D. Nair :—18 Culicidae ; from Nyanza Province, British East Africa.

Mr. S. A. Neave :—69 *Simulium*, 976 Tabanidae, 52 *Glossina*, 4 other Diptera, 4,172 Butterflies, 776 Moths, 6 Cassidid larvae and 2 imagos, 2 Trichoptera, 2 Hymenoptera, 5 Odonata, 2 Rhynchota, 1 Ephemerid, and 30 Ticks ; from British East Africa.

Dr. J. E. S. Old :—A number of Culicidae, 183 Tabanidae, 17 *Glossina*, 3 *Auchmeromyia*, 252 other Diptera, 40 Lepidoptera, 2 Lepidopterous larvae, 208 Hymenoptera, 213 Coleoptera, 2 Planipennia, 13 Myrmeleonid larvae, 94 Rhynchota, 20 Orthoptera, 10 Isoptera, 5 Odonata, 5 Thysanoptera, 78 Mallophaga, 87 Anoplura, 79 Ticks, and 4 other Arachnida ; from Nyasaland.

Dr. W. Owen Prichard :—5 Culicidae, 1 *Haematopota*, 3 *Glossina longipennis*, 2 larvae of *Auchmeromyia*, 5 Hippoboscidae, 2 Ticks, and 2 other Arachnida ; from British East Africa.

Dr. J. Pugh :—52 *Haematopota*, 18 *Glossina*, and 32 other Diptera ; from British East Africa.

Dr. A. C. Rendle :—3 *Haematopota*, 1 *Tabanus*, and 6 *Glossina* ; from Uganda.

Mr. H. Malcolm Ross :—2 Diptera, 13 Coleoptera, 1 Orthopteron, and 7 Rhynchota ; from Maperera, Nyasaland.

Mr. S. W. J. Scholefield :—5 Diptera, 14 Coleoptera, 2 Lepidoptera, 10 Rhynchota, 1 Mantid, 267 Ticks, and 1 Scorpion ; from British East Africa.

Mr. H. Silberrad :—52 *Tabanus*, 13 *Haematopota*, 7 *Glossina*, 6 other Diptera, 61 Hymenoptera, and 10 Ticks ; from West Nyasa.

Mr. G. B. Simpson :—221 Lepidoptera ; from Zungeru, Northern Nigeria.

Mr. C. F. M. Swynnerton :—7 Tabanidae, 40 *Stomoxys*, and 278 other Diptera ; from Mount Chirinda, Southern Rhodesia.

Dr. R. Van Someren :—7 Thrombidiidae ; from Uganda.

Mr. R. P. Woosnam :—5 *Hemimerus* ; from British East Africa.

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ERRATA.

P. 68, lines 9 and 12, transpose the characters of the claspers of the male given for *Phlebotomus perniciosus* and *P. papatasii*.

P. 73 (in synonymy of *Phlebotomus papatasii*), for "*Hermasson minutus*" read "*Haemasson minutus*."

P. 145, for "*Pediculis capitis*" read "*Pediculus capitis*."

P. 148, for "*Coniocotes gigas*" read "*Goniocotes gigas*."

P. 149, for "*Liperus baculus*" and "*Liperus gambensis*" read "*Lipeurus baculus* and "*Lipeurus gambensis*" respectively.

P. 214, line 25, for "protozooal" read "protozoal."

P. 215, table, for "*Chrysops longicornis*, F.," read "*Chrysops longicornis*, Macq."

P. 248, under *O. nemorosus*, for "Rev. E. A. Eaton" read "Rev. A. E. Eaton."

P. 345, table of Culicina, for "*Mucidus mucidus*, Theo.," "*Stegomyia fasciata*, Theo.," and "*Stegomyia sugens*, Theo.," read "*Mucidus mucidus*, Karsch," "*Stegomyia fasciata*, F.," and "*Stegomyia sugens*, Wied.," respectively.

P. 346, table of Tabanidae, for "*Haematopota cordigera*, Aust." and "*Tabanus pluto*, Wied.," read "*Haematopota cordigera*, Big.," and "*Tabanus pluto*, Walk.," respectively.

P. 346, table of Siphonaptera, for "*Ctenocephalus canis*, Dugès," read "*Ctenocephalus canis*, Curtis."

P. 363, title, for "Uganda" read "British East Africa."

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